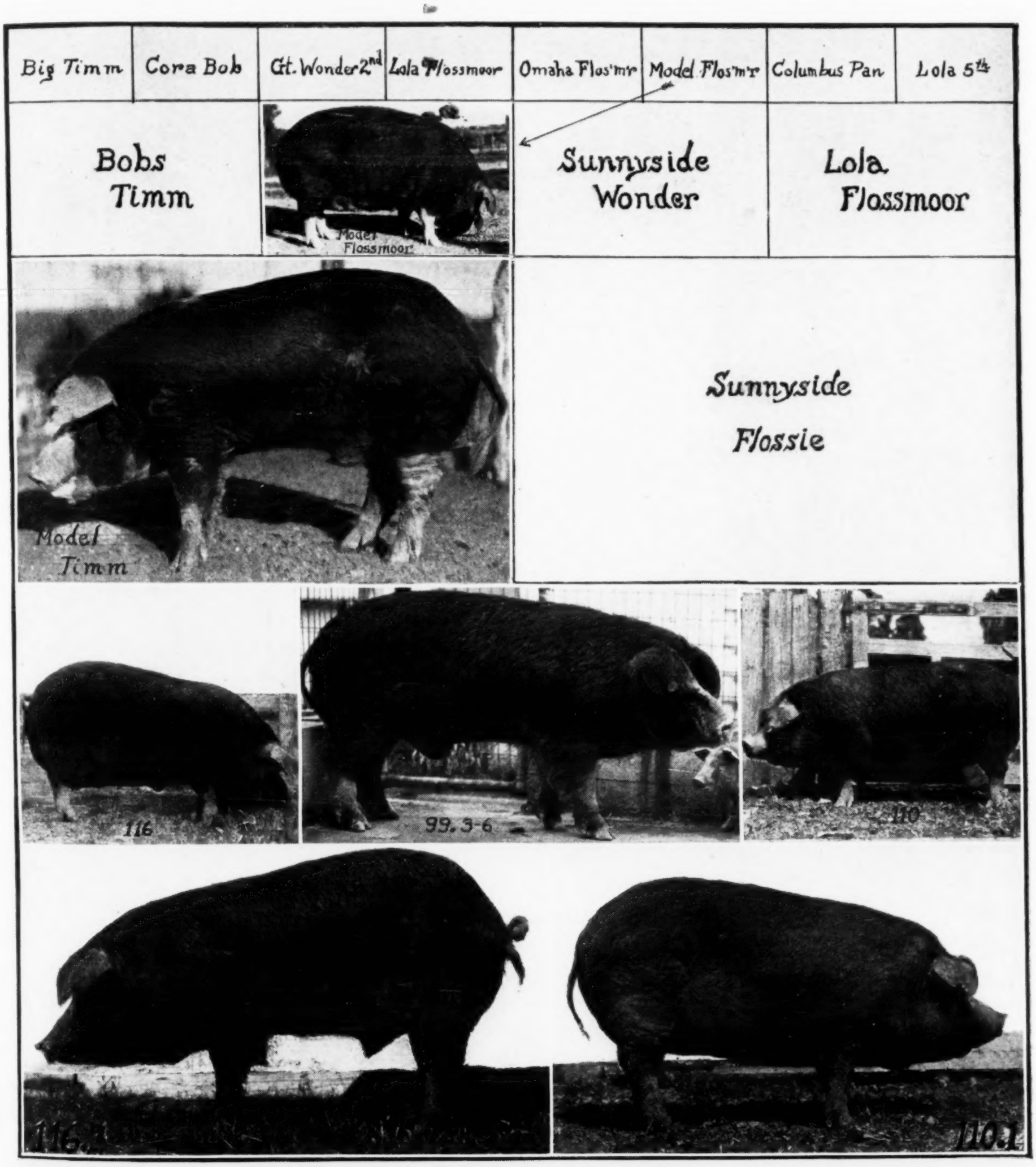
ODICAL ROOM
RAL LIBRARY
OF MICH
JAN 27 1932

The Journal of HEREDITY



18 Ancestors Instead of 62—A Photo-Chart of Inbreeding

(See Page 393)

VOLUME 22 DECEMBER, 1931 NUMBER 12

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

DAVID FAIRCHILD, President — Vice-President, W. E. CASTLE — Secretary, C. E. LEIGHTY

Treasurer, MRS G. W. SINCELL

JOHN B. LARNER, Financial Advisor — Legal Advisors, PEELLE, OGILBY and LESH

EDITORIAL BOARD

Managing Editor: ROBERT C. COOK

M. DEMEREC — R. R. GRAVES — L. C. DUNN

H. J. MULLER — GEORGE M. DARROW — PAUL POPENOE

Members of the Council are ex-officio members of the Editorial Board

COUNCIL

W. E. CASTLE, Professor of Zoology, Harvard University, and Research Associate of the Carnegie Institution of Washington.

LEON J. COLE, Professor of Genetics, University of Wisconsin.

G. N. COLLINS, Botanist, U. S. Department of Agriculture, Washington, D. C.

O. F. COOK, Bionomist in Charge of Breeding Investigations, U. S. Department of Agriculture

DAVID FAIRCHILD, Agricultural Explorer, U. S. Department of Agriculture.

HARRY V. HARLAN, Senior Agronomist in Charge of Barley Investigations, U. S. Department of Agriculture.

SAMUEL J. HOLMES, Professor of Zoology, University of California, Berkeley, California.

C. E. LEIGHTY, Agronomist in Charge of Eastern Wheat Investigations, U. S. Department of Agriculture.

VERNON KELLOGG, Permanent Secretary, National Research Council, Washington, D. C.

J. H. KEMPTON, Bureau of Plant Industry, U. S. Department of Agriculture.

E. W. SHEETS, Chief of Animal Husbandry Division, U. S. Department of Agriculture.

SEWALL WRIGHT, Professor of Zoology, University of Chicago.

ADVISORY COMMITTEE

W. S. ANDERSON, Genetics Department, University of Kentucky, Lexington, Kentucky.

E. B. BABCOCK, Genetics Department, University of California, Berkeley, California.

E. A. BESSEY, Professor of Botany, Michigan State College, East Lansing, Michigan.

A. F. BLAKESLEE, Plant Genetist, Carnegie Institution, Cold Spring Harbor, New York.

J. K. BREITENBECHER, McGill University, Montreal, Canada.

W. E. BRYAN, Professor of Plant Breeding, University of Arizona, Tucson, Arizona.

C. B. DAVENPORT, Director, Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, L. I., New York.

J. A. DETLEFSEN, Professor of Genetics, Wistar Institute, Philadelphia, Pennsylvania.

RUSSELL W. DUCK, Professor of Animal Husbandry, Syracuse University, Syracuse, New York.

E. M. EAST, Professor of Plant Genetics, Bussey Inst. of Applied Biology, Boston, Mass.

R. A. EMERSON, Professor of Plant Breeding, Cornell University, Ithaca, New York.

C. P. GILLETTE, President, The Genetic Foundation, Fort Collins, Colorado.

C. M. GOETHE, Sacramento, California.

HARRISON R. HUNT, Professor of Zoology, Michigan State College, East Lansing.

H. S. JENNINGS, Professor of Zoology, Johns Hopkins University, Baltimore, Maryland.

D. F. JONES, Plant Breeder, Connecticut Agricultural Experiment Station, New Haven, Conn.

M. A. JULL, Senior Poultry Husbandman, U. S. Department of Agriculture, Washington, D. C.

F. B. LINFIELD, Director, Montana Experiment Station, Bozeman, Montana

C. C. LITTLE, Director, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

JAY L. LUSH, Professor in Animal Husbandry, Iowa State College, Ames, Iowa.

H. H. NEWMAN, Professor of Zoology, University of Chicago, Chicago, Ill.

T. S. PALMER, Expert in Game Conservation, U. S. Dept. of Agriculture, Washington, D. C.

JOHN H. PARKER, Professor of Agronomy, Kansas State College, Manhatten, Kansas.

MRS. CHARLES C. RUMSEY, Wheatly Hills, Westbury, Long Island.

JOHN M. SCOTT, Vice Director, Florida Agricultural Experiment Station, Gainesville, Florida.

JOHN W. SCOTT, Professor of Zoology, University of Wyoming, Laramie, Wyoming.

A. D. SHAMEL, Pomologist, U. S. Department of Agriculture, Riverside, California.

GEORGE H. SHULL, Professor of Biology, Princeton University, Princeton, New Jersey.

W. W. SMITH, Professor of Animal Husbandry, Purdue University, Lafayette, Indiana.

CHARLES R. STOCKARD, Professor of Anatomy, Cornell University, New York City.

A. B. STOUT, Director of Laboratories, New York Botanical Gardens, New York City.

W. T. SWINGLE, Plant Physiologist in Charge of Breeding Investigations, U. S. Department of Agriculture, Washington, D. C.

LOU D. SWEET, Seedsman, Denver, Colorado.

W. H. TOMHAVE, American Aberdeen-Angus Breeders' Association, Chicago, Ill.

H. E. WALTER, Professor of Biology, Brown University, Providence, Rhode Island.

H. J. WEBBER, Director, Citrus Experiment Station, Riverside, California.

E. N. WENTWORTH, Armour's Bureau of Agr'l Research and Economics, Chicago, Illinois.

P. W. WHITING, Department of Biology, University of Pittsburgh, Pittsburgh, Pa.

The

Journal of Heredity

Vol. XXII DECEMBER, 1931 No. 12

IN THIS ISSUE

THREE MORE PLANT PATENTS
By R. C. Cook 369

DISTRIBUTION *of* SCHOOL SUCCESS IN FAMILIES
By Howard J. Banker 373

THE INDEPENDENCE OF GENETIC FACTORS GOVERNING SIZE AND SHAPE
By Edmund W. Sinnott 381

AN INBREEDING EXPERIMENT WITH POLAND CHINA SWINE
By Hugh C. McPhee, E. Z. Russel and John Zeller 393

A PRODUCTIVE THORNLESS SPORT OF THE EVERGREEN BLACKBERRY
By George M. Darrow 405

BOOKS RECEIVED 379

ASIATIC AND AMERICAN CENTERS OF CULTIVATED PLANTS 387

A REVISED EDITION OF WALTER'S "GENETICS" 389

PHYSIOLOGY OF THE GREEN PLANT (REV.) 389

SOVIET FACTORY FABLES (REV.) 390

RABBIT GENETICS (REV.) 392

MODERN PLANT BREEDERS GO "BACK TO THE WILD" 392

INDEX TO VOLUME XXII 407

GLOSSARY OF GENETIC TERMS ..... Third Cover

COMING

"Tasters" and "Non-Tasters"

Inherited differences in taste reactions to phenyl thio carbamide and other substances.

Inherited Variations in Eye and Coat Color

In the Chinchilla Rabbit. Of interest for their genetic implications and to practical breeders.

Role of Bud Variations in Apple Improvement

Just what part does bud variation take in the development of new variations?

Fertile Gynandromorphs of Habrobracon

When a wasp's head is male and the rest of it is female, and *vice versa*, how do the resulting organisms behave?

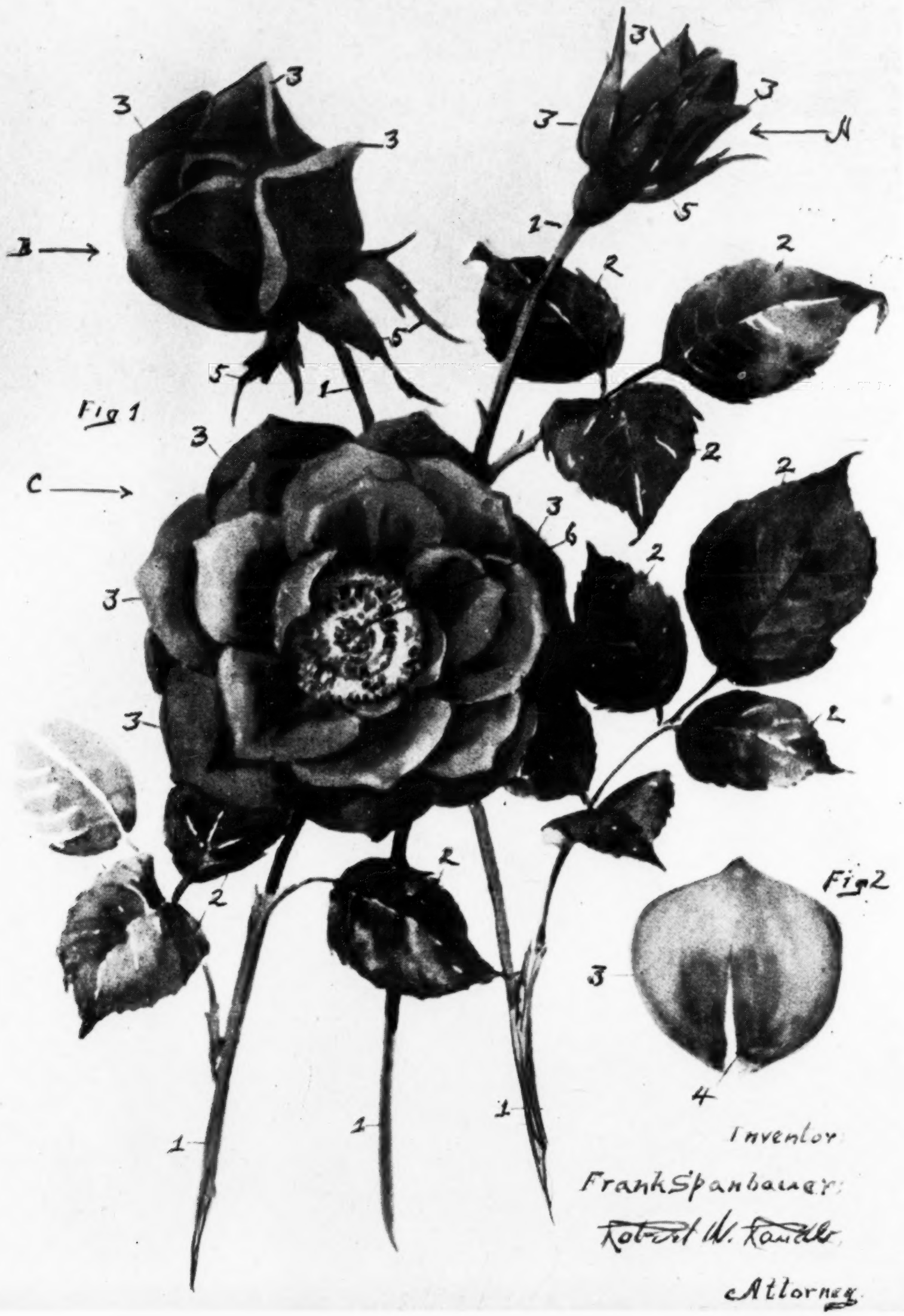
The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION, at 1918-32 Harford Avenue, Baltimore, Md., and Victor Building, Washington, D. C. Address all communications regarding editorial matters and the business management of the Association to Room 306, Victor Building, Washington, D. C. Entered as second-class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized December 20, 1918. Contents copyrighted 1931 by the American Genetic Association. Unauthorized reproduction of material from THE JOURNAL not permitted. The title "Journal of Heredity" is registered as a trade-mark in the U. S. Patent Office.

$3.50 a Year *Prices of back numbers on application* ***35c. the Copy***

Oct. 13, 1931. F. SPANBAUER Plant Pat 2

ROSE

Filed July 1, 1930



THE FIRST PLANT PATENT ISSUED FOR A VARIETY PRODUCED BY HYBRIDIZATION

Frontispiece

Drawing accompanying the patent application of Joseph Spanbauer, for a new variety of red rose, produced by hybridization of "General Jacqueminot" and "Richmond" roses. The illustration is produced in color in the copies of the patent issued by the Patent Office. This is the first drawing to be issued in color by the Patent Office. The text of this patent is reproduced in Figure 1.

THREE MORE PLANT PATENTS

Plant Patents 2, 3, and 4 Issued—Patent Drawings in Color—Need for Type Plant Emphasized—Contrasts Between Mechanical and Botanical Inventions

THREE more plant patents have appeared. Plant Patent 2 is for a red rose, a hybrid of General Jacqueminot and Richmond. Plant Patent 3 is a carnation, and Plant Patent 4 is the thornless dewberry described in this *Journal* in 1929 (Volume 20, pp. 567-569).

Plant Patent 2 has the distinction of being the first patent to be printed in color. The color plate of the rose is lithographed, and seems an excellent likeness. We cannot but be skeptical as to the real value of such color plates in actual use to determine anything so variable as plant colors. In different soils, and on different years in the same soil, flower-colors will vary considerably —even enormously in some cases. The only hope of attaining reality in plant-variety determination is to refer back to definite type-plants. Budding to them will give as near as is possible an actual determination of infringement. Reference even to faithful color reproductions will rarely be conclusive. This further emphasizes the fact commented on earlier, that the granting of plant patents is really more of an innovation than has been generally realized, and that the success of the experiment depends on a very radical revision, or even reversal, of some practices now considered an integral part of patent law and practice.

Plant Patent 3 is a "white" carnation. Here again the difficulties of color-rendering are evident. The specification emphasizes strongly the whiteness of the flower, and yet the color illustration shows a distinctly yellow-green flower! Whether the words or the drawing represent the actual situation is again a mystery that in the absence of an actual plant would baffle a Solomon.

Plant Patent 4 is a thornless and productive sport of the Young dewberry. It arose in a field planting, and here again the question may be raised (and quite likely will be) of the patentability of a purely adventitious sport.

The *Journal of Heredity* has the distinction of being the first publication cited in a plant patent specification, when the "discoverers" of plant patent 4 make reference to the article and illustrations of this thornless form published in our *Journal* in 1929.

Of the first four patents only one has been granted for a plant produced by the exercise of the breeder's art The other three are admittedly mutations and the question whether such varieties are inventions is still undetermined. The inventor of the new white carnation endeavors to meet this difficulty in the specification: "This new carnation was first discovered by me on or about March 1, 1929, as a result of careful and systematic observations made by me for such purpose. This new variety was found by me as a sport on a plant of pink Sophelia. I immediately took steps . . ." The question of whether any really inventive faculty had been demonstrated is hardly met by these statements. That the discoverer expected a white sport of a pink variety to occur and that he was impatiently awaiting this "blessed event" is a picture that may satisfy legal technicalities in spite of any effect it may have on the risibilities of plantsmen. Was anything done that anyone "skilled in the art" of floriculture would not have done? If the ratio of patents issued (four for mutations to one for a new variety produced by hybridization) is maintained in later patents, it is evident that this point is very important.

A Variety Produced by Hybridization

The case is quite different with regard to Plant Patent 2. Here the appli-

UNITED STATES PATENT OFFICE

FRANK SPANBAUER, OF NORTH KANSAS CITY, MISSOURI

ROSE

Application filed July 1, 1930. Serial No. 465,160.

The object of this invention, broadly stated, is the production of a new flower, or more particularly a new and distinct variety of the species or genus "Rosa"; the same being produced and propagated by intensive cultivation, scientifically conducted, by means of hybridization and inter-crossing, in order to bring out and develop the most desirable features possible, thereby eventuating in the production of a new rose which is unique in character, highly delectable and aesthetic to one's sense of sight, as well as pleasant to one's sense of smell, which can be asexually reproduced, and in which the characteristics thereof are permanently fixed.

More specifically stated, my invention consists in the production of a new and distinct variety of rose, the same being recognizable by producing cordate, or heart-shaped, petals; emitting a high degree of fragrance, of an extremely delicate desirable quality which is unusually prolific in growth; is of strong, vigorous, and quick growth; has extra long stems; is practically free from diseases; produces more stems and a greater number of blooms to each bush; produces blooms of an unusually large size; and with a greater number of petals to each bloom; and many other desirable features are inherent therein which are not found in other roses.

My new rose is especially noticeable as predominately scarlet crimson in color, with a white streak in the center of the inner portion of the petals. My new rose is unusually hardy in growth and in disease resistance; it has a high degree of resistance against insects, blight, fungi, and atmospheric influences; being also high in ever-blooming and storage qualities, and in ease of asexual reproduction; and which retains its fragrance and beauty for an unusually long period of time.

My new rose is produced by hybridization, cross-fertilizing, and careful breeding, and it has been developed, propagated, tested, and asexually reproduced to provide a new variety having distinct characteristics which are easily distinguishable and which, it is believed, are permanently fixed and is susceptible of being asexually reproduced indefinitely upon a commercial scale.

My new rose was developed substantially as follows: The two varieties of roses used as the progenitors were the "General Jacqueminot rose", as the male member and the "Richmond rose", as the female member. From the stamens of the male member pollen was taken and placed in the stigma of the female member. From these the seed formed in the female member was sown in soil and brought forth male and female roses, which for identification only I denominate as "No. 5" being the male and "No. 1" the female. When Nos. 1 and 2 are fully open in bloom then the pollen from the stamens of No. 5, was at the proper time, placed in the stigmas of No. 1, thereby crossing No. 5 and No. 1, which produced my new rose, which is therefore a hybrid Tea rose.

My new rose was then asexually reproduced and propagated, and it has also been improved, by intercrossing and otherwise, whereby the individuality and the desirable characteristics of my rose has been greatly improved and its characteristics are fixed.

All parts of the petals of my rose are scarlet crimson in color, except at the base of the middle of the outer petals where there is a white streak extending about one-fourth of the way up. The petals of my rose are inclined to be cordate in form, thereby adding to their beauty, novelty, and individuality.

In the accompanying drawings, forming a part of this specification, I have shown my perfected rose in three stages of its natural developement, that is in blooming, the same including the bud, the partly open bloom, and the full bloom rose. The drawings also show the new features which are visible, but of course does not show the new features which are indiscernible to one's eyes.

The drawings show my rose in its natural colors, that is as near as is possible to do artificially.

In the drawings Figure 1 shows my new rose in its natural colors, in bud, in half-bloom and in full bloom.

Figure 2 is a plan view of the inner sides of one of the petals.

Letter A denotes the bud, B denotes the half-bloom; and C denotes the full bloom.

More specifically,—numeral 1 denotes stems; numeral 2 denotes leaves; numeral 3 denotes petals; numeral 4 denotes the white streak which streaks are on the inside face of the petals, or at least most of them, and which are more pronounced on the inner face of the outer petals, and in the drawings only one of them appear, and that in Fig. 2. Numeral 5 denotes the sepals forming the calyx; and numeral 6 denotes the pistil or regenerative organs.

It is to be understood that various changes may be made in the procedure, and in the details set forth, without departing from the spirit of my invention or sacrificing any of the advantages thereof which are new.

Having now fully shown and described my new rose, and the mode of its production, what I claim and desire to secure by Letters Patent of the United States, is—

A rose substantially as herein shown and described, characterized and predominantly distinguished by petals which are scarlet crimson in color, semi-double in appearance, and in which the outer petals are inclined to be cordate in shape.

In testimony whereof I have hereunto subscribed my name.

FRANK SPANBAUER.

Patented Oct. 20, 1931 Plant Pat. 3

UNITED STATES PATENT OFFICE

OTTO A. MÜLLER, OF AMBLER, PENNSYLVANIA, ASSIGNOR TO THE FLOREX GARDENS, OF NORTH WALES, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

CARNATION

Application filed May 14, 1931. Serial No. 537,455.

My invention relates to improvements in fragrant, white carnations of the type ordinarily known as perpetual blooming or greenhouse forcing carnations. The object of my improvement is to provide a white carnation of the type mentioned having unusually large size, heavy petalage and full, high centers; having a calyx so constructed as to support this type of flower without bursting; having a stiff, unusually long stem capable of supporting such a large and heavy flower; and having superior qualities of productiveness, reproduction and long retention of its fresh appearance when cut, as well as other desirable qualities.

This new carnation was first discovered by me on or about March 1, 1929, as a result of careful and systematic observations made by me for such purpose. This new variety was found as a sport on a plant of pink Sophelia. I immediately took steps to reproduce and develop this new variety and have done so continuously since that time. In constitution, growth and size of bloom as well as in other qualities it greatly surpasses its pink parent Sophelia. This new carnation has not yet been offered for sale.

The accompanying illustrations show in full color and about natural size, a bud, a half opened flower and a fully opened flower of my new carnation.

The following is a detailed description of this new carnation:

An upright, vigorous growing plant 3 to 4 feet in height, a splendid producer and of strong constitution resistant to disease.

Flowers: Pure white to the casual observer but upon close inspection one to five petals in nearly every flower are found to have a slight edging or flecking of pink, also a slightly creamy tint on some of the central petals is noticeable to the artist skilled in analyzing color and shadow values; under ordinary good culture blossoms grow 3½ to 4 inches in diameter, the size being attained partly by unusual length of outside petals and partly by the great number of petals; petals number about 75 to 80 in a normal blossom if all small petals are counted; edges rather deeply and irregularly toothed and partially folded and longitudinally curled so as to give a crinkled appearance, petals are exceedingly numerous and close together in central portion of flower completely filling the center and generally concealing the styles although occasionally the tops of the two curved white styles are visible among the closely set petals. Two styles arise from the seed pod or if considered as a single style it branches into two parts just as it emerges from the seed pod. The flower has a high center making it practically semi-spherical. The petals are of a texture not easily damaged or bruised. Moderately fragrant.

Calyx: The calyx is relatively short and wide at the top, measuring an inch or more across at the top. It consists of a single tube one and one-quarter inches long, made up of five subdivisions or lips separated at the top by moderately deep indentations. This gives a spreading or open mouth effect which aids in preventing bursting of the calyx, an important point due to the extreme fullness of the flower. Each of the five calyx lips is provided with a humped spring-like development which, while tending to hold the flower together in a compact mass, gives the necessary elasticity to prevent the bursting of the calyx cup. The calyx cup is further reinforced by well developed bracts at its base which reach up one third the distance to the top of the calyx cup.

Buds: Relatively short and wide. When half opened the center of the flower has a distinct cream tinge which lessens as the flower opens further and when full blown the creamy tint is scarcely noticeable except to a color artist.

Stems and foliage: Stems are from 36 to 43 inches long, smooth, stiff and amply capable of supporting the heavy flower; deep dark green in color although overcast with a gray bloom, and having rather short blunt leaves, characterized by their tendency to roll or curl extremely and tightly. The last four or five pairs of leaves nearest the flower roll into curls consisting of one to two and one half turns and lie close up to the stem. The fourth pair of leaves below the flower are

SPECIFICATIONS OF PLANT PATENTS THUS FAR ISSUED

Figure 1

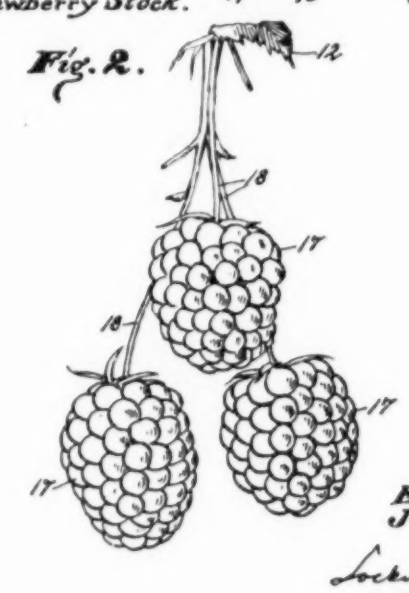
Oct. 20, 1931. E. L. POLLARD ET AL Plant Pat. 4

THORNLESS YOUNG DEWBERRY

Filed Oct. 6, 1930

Fig. 1.

Fig. 2.



Discoverers.
Elmer L. Pollard.
Jubal E. Sherrill.
by
Lockwood & Lockwood
Their Attorneys.

usually not over 2¼ inches long and about ⅜ inches wide at their widest point.

The more important features which I believe distinguish my new carnation from all other known varieties are:

First; the flower is very large—larger than any other white carnation known to me and larger than most colored carnations.

Second; it has a larger number of petals than any other existing white carnation known to me. When the small petals are all included the number runs 75 to 80. Omitting the smallest petals and comparing with other white varieties on the same basis, the relative counts are as follows:

	Petals
My new variety	66
Arctic	57
Senator	42
White Matchless	41

Third; the flower has a fuller, higher center than most other white varieties, thus giving it a somewhat hemi-spherical appearance, a character much desired by florists.

Fourth; the calyx cup is short and wide and has much more pronounced developments for preventing splitting, than do most other varieties. This is highly important in a carnation as full and heavy as is my new variety. Chief among these improved calyx-cup characters are (*a*) the short, wide-mouthed, stout structure (*b*) the moderately deep, well-formed slits between the lips of the calyx cup (*c*) the unusually large humped, spring-like developments on the lips of the calyx cup which give a high degree of elasticity and prevent bursting.

Fifth; the leaves beginning some four inches below the flower and including the next four or five pairs below, are rolled much more tightly than in any other white variety known to me. These leaves are also relatively short and blunt as compared to most other varieties.

Sixth; flowers cut and placed in water will under ordinary conditions retain their freshness of appearance ten days to two weeks—a period much longer than that of the usual carnation.

Seventh; this variety is an exceptionally easy propagator and makes a noticeably vigorous growth as compared with rooted cuttings of other varieties grown alongside. Other desirable qualities are great length of stem and satisfactory quality of flower production.

I claim:

The carnation as shown and described, characterized particularly by its white blossom slightly flecked with pink, unusually large in size and having a high center; its strongly constructed calyx; its stiff, unusually long stem; and its superior reproductive and keeping qualities.

OTTO A. MÜLLER.

Patented Oct. 20, 1931 Plant Pat. 4

UNITED STATES PATENT OFFICE

ELMER L. POLLARD AND JUBAL E. SHERRILL, OF CHINO, CALIFORNIA

THORNLESS YOUNG DEWBERRY

Application filed October 6, 1930. Serial No. 486,338.

This discovery relates to a new fruit bearing plant of the Young dewberry variety, which plant was discovered as a sport that indicated an individual variation from the parent stock or vine in the notable respect that it was thornless.

This sport, after a further development, indicated that its individual thornless characteristic was a permanent feature of the plant and that through it an entirely new thornless variety of Young dewberry has been developed.

The original thornless sport or bud was discovered by us on a vine growing in a ten acre field of thorny berry vines that are commonly known as "Young dewberries" and which on the Pacific Coast are commonly known as "Youngberries".

As is well known, the vine of the Young dewberry as well as all other species of dewberries known to us, are quite thickly covered with sharp thorns that not only are on the vines but also in varied sizes extend along the fruit and leaf stems, so it is quite difficult to gather the berries without the pickers injuring their hands. The thorns not only cause painful wounds on the pickers' hands but also tear their clothing and generally impede their labor.

Knowing how generally beneficial it would be to have a thornless variety of Young dewberry we took special care to propagate this thornless vine and in its cultivation and development endeavored to make permanent its thornless feature, which we have succeeded in doing.

In this connection we furnished specimens in 1928 to George M. Darrow who, at that time was senior pomologist of the Bureau of Plant Industry in the U. S. Department of Agriculture, and who later wrote an article entitled "Thornless sports of the Young dewberry" that was published in the Journal of Heredity for December, 1929, pp. 567–569 in which he mentioned the identical mutation of the Young dewberry that was found by us in 1928 and furnished to him. Since that time we have been continuously cultivating this new thornless variety of berries and on a sufficiently large scale and for a length of time to justify and prove our claim that it is a new thornless variety.

The accompanying drawings illustrate the thornless character of the Young dewberry, in which:

Fig. 1 is a grouped view of the parent thorny dewberry plant compared with its thornless product, also showing a comparison of the foliage.

Fig. 2 is a view of a cluster of the thornless dewberry fruit with leaves and part of the fruit cluster cut away to better show three berries about actual size on their thornless stems.

The discovery of the new thornless dewberry and its care and propagation and general characteristics are more particularly described as follows:

The sport was discovered growing in a ten acre field of Young dewberries with the parent vines heavily covered with thorns, and the discovery was made in the summer of 1928 on plant Number 1 and row 27 in a plot of ground known as Hayden Field, that is located about one mile west of Chino, California.

This sport and the product thereof have been under our constant care, attention and cultivation since the above date and we have propagated it on an extensive scale with thousands of the thornless plants ready for distribution to the public, and in this extensive development this plant holds its thornless characteristic perfectly and is deemed to be an entirely new variety of dewberry that is thornless in every respect.

The plant is a very strong grower, trailing in habit and propagates from the tips of the vines and has a relatively heavy foliage. The fruit is very large, dark wine color, very little acid, few seeds, flavor much like the red raspberry, is very productive and seasons early.

In the drawings Fig. 1 shows our thornless dewberry arranged slightly above its parent plant and, as seen therein, its vine 10, stem 11 and leaf 12 are entirely free of the thorns 13 shown on the vine 14, stem 15 and leaf 16 of the parent stock.

In Fig. 2 a cluster of our thornless dewberry fruit is shown with part of the cluster and leaves cut away to more clearly show three of the berries 17 about actual size hanging on stems 18 that are thornless.

The color of the fruit is not shown, but is previously described as a dark wine color.

We claim:

A dewberry as herein shown and described characterized by the absence of thorns.

In witness whereof, we have hereunto affixed our signatures.

ELMER L. POLLARD.
JUBAL E. SHERRILL.

SPECIFICATIONS OF PLANT PATENTS 2, 3 AND 4

Figure 2

Specifications, about a third actual size, of the plant patents issued before Nov. 1, 1931. The drawing accompanying Plant Patent 2 is reproduced in the Frontispiece. The drawing of the carnation in Plant Patent 3 is also in color. The specification emphasizes the whiteness of the flower, but the drawing shows a yellow-green flower! The difficulty of deciding whether two varieties are identical or different by means of such drawings is obvious. The use of the term "Discoverers" in the signature on the drawing accompanying plant patent 4 is an innovation.

cant states: "My new rose is produced by hybridization, cross fertilizing and careful breeding, and it has been developed, propagated, tested, and asexually reproduced to provide a new variety having distinct characteristics . . ."

The description of steps taken is fairly clear except for the following: "My new rose was then asexually reproduced and propagated, and it has also been improved by intercrossing and otherwise . . . whereby the desirable characters have been greatly improved and its characters fixed." It is hard to form any clear idea of what part these processes had in the production of the new form, or of just what was done. That the inventor had the *same* rose after further crossing is incredible. Probably the matter is not important, as a repetition of the process would not be likely to produce the same result again, but the description as it stands is distinctly lacking in meaning. In spite of this difficulty, it is the only patent of the first four which appears to offer a real example of a plant "invention" that conforms to existing concepts of patents. The peculiar skill of the plant breeder, and the application of his art, has produced a new form through hybridization and selection.

Plant Patents Cannot be "Disclosed"

In the description of what has been done to produce this result we have another carry-over from present patent practice. The theory of a patent is that in exchange for monopoly privileges the inventor "discloses" his invention, so that the technique of making it becomes public property. We understand that in the case of many of the German chemical patents issued before the war, the processes of manufacturing the compounds were deliberately garbled, so that a person "skilled in the art" would have been likely to have found himself precipitately departing on his last journey had he mixed the ingredients according to the directions given. In the case of plant patents another situation arises. The breeder can tell what steps he took to get his variety, and these may be very important in establishing his right to the discovery or invention of the variety. Nevertheless a detailed account of the technique used would not assure that other persons "skilled in the art" would get the same result. It is quite certain that in most instances the inventor himself could not produce the same variety again. He might occasionally produce a very similar form, but the probabilities are all against its being identical.

This is really not important from the point of view of society because with plants the steps do not need to be repeated to get other units of the new variety. As long as a single plant exists it can be propagated, and after all are gone the variety can probably never be exactly reproduced. Thus the purpose of the specification in a plant patent is different from its purpose in other patents, and this difference should be recognized and the form of the specification modified accordingly.

ROBERT C. COOK.

A Glossary of Genetic Terms

Attention is called to the glossary of genetic terms appearing on the inside back cover of each issue of the JOURNAL. In this it is proposed to define the technical words used in each issue, of which definitions are not readily available.

DISTRIBUTION OF SCHOOL SUCCESS IN FAMILIES

HOWARD J. BANKER

Carnegie Institution of Washington, Department of Genetics, Cold Spring Harbor, N. Y.

AFTER many years of diligent research the writer has devised a fairly uniform index of school success applicable to students in all grades of educational progress when the records are reasonably complete and carefully kept. Such records are to be found in nearly all institutions at times, and occasionally though rarely will be found covering long intervals.

In brief, the formula adopted for this index is as follows:

$$\text{SAI} = \frac{Mk}{CA} \times \frac{MEA}{GMk}$$

It is not easy, however, to explain fully the meaning of these symbols and the computation of the index, or *SAI*, for any student is not as simple as the formula would suggest.* In fact, several types of indexes may be computed according to the premises which may be assumed as a basis for the computations. But if the same premises are adhered to in any series of indexes a fairly consistent result may be obtained throughout an educational system from the lowest to the highest grade, at least as uniform as the character of the records will permit. The full meaning of such a qualified generalization will be best understood as we follow the results of the use of this index in the following study. Those who may be interested in the development of the formula and its various modifications are referred to previous papers by the writer.†

For lack of space and to avoid tedious discussion we will not attempt to elaborate more fully the procedure of computing a student's ability index (*SAI*) but will undertake to show the results obtained from its use in a specific problem. It has long been evident that the work accomplished by students in school was theoretically a measure in some degree of their mental ability at corresponding years of development. While the *SAI* cannot be said to be an exact measure of the mental ability of students it appears to be the most correct measure yet devised of the ability of students for school success at differ-

*In general, we may say that *Mk* is the average of the individual student's marks over a given period and for a specified number of subjects. It may, therefore, be modified for any specific problem both as to the time involved and as to the subjects considered, but should be the same as to time and subjects for all individuals that are to be compared in the same problem. *CA* is the individual student's chronological age at the time for which the average of marks is computed. *MEA* is the mean educational age of the group of students with which the individual is associated. This is a technical expression whose exact meaning is to be fully understood only by a study of its derivation, for which see an unpublished paper on "The Student's Ability Index in Higher Educational Institutions." Its numerical value in many cases can be read directly from tables prepared for the purpose, but in using such a table it must be remembered that it involves a definite time factor that cannot be ignored. *GMk* is the average mark received by the associated group of students for the same time and subjects as for each individual's mark (*Mk*). It will be seen that before the formula itself can be employed in the computation of a student's index (*SAI*) each of these four factors must be determined with a due regard for all the variable elements involved and each of the latter must be maintained constant for all the students included in any single problem. Hence, the task of computing a large series of indexes is not only exacting but is exceedingly laborious where sufficient numbers for statistical purposes are to be obtained.

†*Journal Educational Research* 13:155-170; 16:159-171, 271-284; 17:357-364; 18:282-289; 20:31-37; 23:273-279.

ent periods and may, therefore, be used for the comparison of such success in parents and children at the same age although separated by long intervals of time. At least, as there is no better means of comparison available we may make the attempt and see what are the results.

School Records

For this purpose two institutions or school systems were selected for the reason that their records were unusually complete over a long period of time and that their students included many families in which parents and children attended the same institution in their early years. The first of these was the Huntington school system at Huntington, N. Y., a public school system including both elementary and high school departments and whose records are almost complete from 1859 to 1930, giving not only the name, age and attendance of each student but in most cases the average marks in each subject. The second institution was Swarthmore College at Swarthmore, Pa., a very different institution, as to locality, type of work and constitution of student families. The records of the College were, however, equally complete and full from about 1870 to the present. The *SAI*'s of hundreds of students in these institutions were computed, based on the academic work only and determined for each term or semester as was available without discrimination between the two.

Finally the average *SAI* for all terms or semesters that the student was in school was taken for the student's final index in our comparative studies. In this manner the *SAI*'s were computed for 470 students of the Fourth to Eighth Grades inclusive in the Huntington Elementary School, 352 Huntington High School students and 342 Swarthmore College students making a total of over 1,000 students covering a period of 60 to 70 years and including two and often three generations of a family.

The Average SAI

Theoretically the average student of the general population should have an *SAI* of approximately 100. Owing to the selective effect of school work in any group as it advances from grade to grade we may expect the mean *SAI* of a school population to gradually increase and we find that the mean *SAI* of our 470 elementary students, who are all in the higher half of the elementary school work, is actually 104.17. From this it is evident that with the high school and college groups of students we should expect the mean *SAI* to rise yet higher. We actually find that the mean *SAI* of the 352 Huntington High School students is 104.46, which is not appreciably higher than for the elementary school students. Now we find that the mean *SAI* computed from the high school records of 236 students who also had an elementary school record was 103.98, which is very near the 104.46 obtained for the 352 unselected Huntington High School group and is not essentially different from the mean of 104.17 obtained for the 470 unselected elementary students. If, however, we compute the mean *SAI* of these 236 selected students from their elementary school record we find it to be 111.36. It is at once evident that some factor in the high school conditions has materially affected the value of the *SAI*, which should be approximately the same, if the student's record is correct, whether computed from elementary or high school data. In reality we find that the mean *SAI* has dropped over seven points in the high school. Further investigation shows that this drop in value occurs practically at the beginning of the high school course and thereafter rises normally from year to year as selection eliminates the poorer students.

Correction for Advanced Scores

The explanation of this anomaly appears to be that on entrance to the high school there is a drastic selection

of the students, as is the experience of every educator. Of the students that fail to enter the high school, a large percentage are the poorest students and especially those whose marks run below say 80 or its equivalent. As a consequence, the students who enter high school have a higher average of marks than the elementary group as a whole, but, since the high school teachers mark this promoted fraction on the same scale as before, many of them must be marked lower than they were in their elementary work and the average of the high school group declines causing the mean *SAI* to fall relatively too low by about 7 to 7.5 points. This is no fault in the marking judgment of the teachers but is strictly one of the exigencies of the marking system which does not provide for the necessity of a biological selection in school progress. This source of error affects the poorer students of the high school group more than it does the better, and a perfect method of correction should take this into consideration. The most simple and practicable method, however, is to add to each high school *SAI* an arbitrary increment determined by experience so that for higher institutions the formula may be written:

$$\text{SAI} = \frac{Mk}{CA} \times \frac{MEA}{GMk} + K$$

In this way each Huntington High School and each Swarthmore College *SAI* as computed was increased by the arbitrary constant 7.3 = K.

Such a correction has no effect on the relative measure of the ability of students within the same institution and may or may not be employed as is convenient, but some such correction is essential when comparing the ability of students as measured by the *SAI* computed from their elementary school record with the ability of the same students or others computed from the records of higher schools.

From this discussion it seems evident that, though the *SAI* as an index of student ability is by far the most accurate and efficient measure yet devised as a standard expression of student achievement over long periods of time and under a large variety of conditions, it is still far from the point of ideal perfection, and it can not be used indifferently in the solution of every problem. This may lead us to appreciate more fully the results obtained in the present study.

Distribution of SAI's

The distribution of the hundreds of *SAI's* in each institution was found to give in every case a typical Gaussian Curve, sometimes slightly skewed. This fact suggested dividing the students into classes or types of ability in proportion to the distribution of the *SAI's*. For this purpose the distribution of the 470 *SAI's* obtained from the Huntington Elementary School was adopted as fundamental. While by no means including all of the students, they seemingly furnished an ample unselected sample

TABLE I—Comparison of school success in families of selected types as measured by the SAI from elementary school records. Types of ability: *L* = less than 94; *M* = 94-116; *H* = 116 and above.

Type of Parental Mating	No. of Families	No. of Children	Average *SAI*'s		
			Midparents		Children
			Expected	Observed	
L × L	3	9	82.9	86.5	97.2
L × M	14	27	94.2	95.	101.7
L × H	2	6	103.6	99.4	113.1
M × M	13	21	105.6	104.2	113.6
M × H	8	15	114.6	112.1	116.6
H × H	3	6	123.8	125.9	118.8
Totals	43	84	104.1	103.8	110.2

of the five highest grades and gave a distribution having a mean of 104.17, a median of 105.95, 1st Quartile 93.53, and 3rd Quartile 115.37. Such a distribution would seem to be essentially normal and gave confidence that the *SAI's* were not widely at variance. The following types of ability were, therefore, adopted: low (*L*) for all with an *SAI* below 94, median (*M*) for those having an *SAI* of 94 to 116, and high (*H*) for those with an *SAI* of 116 or more. These expressions must be understood as strictly relative. Low does not mean feeble-minded or low-grade intelligence. These students are already a selected lot and average in mental capacity above the average of the general population.

On this basis as to types of ability, as many of these elementary students as stood in the relation of parents or children to each other were compiled into the preceding comparative table according to types of parental matings. The column of expected midparents' average *SAI's* is based on the assumption that all of the 470 students of whom we have elementary school data had become parents. This serves as a check on the adequacy of the actual data in the several categories of the table.

It is evident that in some categories the data are inadequate for very accurate results. This is especially the case in $L \times L$, $L \times H$ and $H \times H$ matings. The first may be due to such a mating tending to give children who do not make good in school and such families are not, therefore, largely represented in the table. This interpretation appears to be confirmed by the fact that the observed average for these midparents (86.5) is higher than the expected average, indicating that the lower grades of such matings are eliminated. If this is true and the families are omitted because the children fail to make the higher grades of the elementary school, it is evident that the average for "children's *SAI's*" if all were accounted would be something less than 97.2, the present average. $L \times H$ matings are rare, presumably owing to selective mating, which means that extreme abilities do not often mate, while $H \times H$ matings are few perhaps because the highest types either fail to mate or mate elsewhere and their children, if any, are not included in our data. In the two latter classes of matings, the averages for both midparents and children are presumably affected in no definite manner except that the data are rendered inadequate for exact statistical results.

In spite of these imperfections, some facts seem to stand out with conspicuous prominence. The children's averages rise steadily with the rise of the midparents'. Low parentage gives low average children and high parentage gives high average children. The usual statistical phenomenon of regression toward mediocrity is evident but presumably has no significance except as showing that the data run true to

TABLE II—Comparison of school success in families of selected types as measured by the SAI from high school records.

Type of Parental Mating	No. of Families	No. of Children	Average *SAI*'s		
			Midparents		Children
			Expected	Observed	
L × L	1	5	87.9	81.6	112.4
L × M	3	5	96.9	97.4	112.2
L × H	4	7	106.5	106.3	114.1
M × M	15	24	105.9	107.1	106.3
M × H	11	21	115.5	116.4	112.8
H × H	14	33	125.1	129.2	119.9
Totals	48	95	106.3	106.3	113.

statistical form. It is of interest to observe that the $L \times H$ and the $M \times M$ matings yield essentially the same average for the children, 113.1 and 113.6 respectively. The total average of children, 110.2, is much higher than that of parents and suggests that for some reason children make a better school record than their parents. This may be due to better methods of instruction, increased interest in school work or more generous markings. It hardly seems possible that it means an increased average of innate ability in the population.

Table II gives the results as obtained from a like compilation of data from the Huntington High School records. Types of ability as before.

As compared with the previous table it may be noted that the numbers of families in the lower categories of matings are fewer and the numbers in the higher categories are increased. This is evidently due to selection in the high school for a higher type of student. That is, relatively few families in which the *SAI* of at least one parent is less than 94 have children in high school. In other respects, it is seen that the table tells much the same story as the previous table but with manifestly greater irregularity. In general, the average *SAI's* for the children increase with the midparental averages but not quite so steadily. The increased irregularity in the results is doubtless due in part to the inadequately small numbers for statistical work in the lower categories of the table but also in part to the increased number and variability of the factors affecting the success of the high school student as compared with his elementary school activities, rendering the *SAI* less constant and reliable as a measure of his true ability.

College SAI's

Table III presents data compiled from a similar study of the students in Swarthmore College, a wholly independent institution and of much higher rank, the types of ability being taken the same as before.

As was to be expected, greater differences appear between this table and the preceding, yet one general truth remains unchanged; the average *SAI's* of the children rise consistently with the increase of the midparental averages. Regardless of other variations our three institutions agree in emphasizing one general law; the greater the school ability of the parents the greater the school ability of the children

Even some of the conspicuous differences in this table based on a college constituency are in themselves of significance. In the elementary school 25 per cent of the 470 students whose records are known were "low" (L), that is, had less than 94 as their *SAI;* in the high school 11 1/3 per cent of the 352 computed *SAI's* were L; in the college about 6 per cent of the 342 computed *SAI's* were L. This shows how selection in the higher institutions tends to eliminate the L students. In the high school only one family of

TABLE III—Comparison of school success in families of selected types as measured by the SAI from college records.

Type of Parental Mating	No. of Families	No. of Children	Average *SAI*'s		
			Midparents		Children
			Expected	Observed	
L × L	0		85.6		
L × M	3	8	95.7	96.9	101.7
L × H	1	1	105.4	106.2	103.5
M × M	3	5	105.8	101.9	105.1
M × H	18	32	115.5	117.8	108.6
H × H	16	35	125.2	127.3	114.9
Totals	41	81	105.5	110.0	106.8

$L \times L$ parentage had children in high school and in the college not even one family of such parentage had children who entered college.

Table IV, by combining data from both the elementary and high school records of the Huntington schools, permits an increase in the numbers since some families may have members whose records are in one school but not in the other. The types of ability are, of course, the same as before.

The increase in numbers tends to give greater statistical constancy, but even then we find some categories woefully inedquate, as for example $L \times L$ and $L \times H$. Moreover, combining the high school records with the elementary gives an increased irregularity as compared with the latter alone. But the facts

TABLE IV—Comparison of school success in families of selected types as measured by the SAI from elementary and high school records.

Type of Parental Mating	No. of Families	No. of Children	Average *SAI*'s		
			Midparents		Children
			Expected	Observed	
L × L	3	9	85.4	86.5	98.2
L × M	16	32	95.6	95.3	102.8
L × H	2	6	102.2	99.6	111.3
M × M	22	42	105.7	105.8	107.3
M × H	18	31	115.0	115.1	114.5
H × H	12	32	124.4	130.3	120.5
Totals	73	152	104.7	105.4	109.1

TABLE V—Cumulative comparison of school success in families of selected types as measured by the SAI from school records.

Type of Parental Mating	No. of Families	No. of Children	Average *SAI*'s		
			Midparents		Children
			Expected	Observed	
L × L	3	9	85.5	86.5	98.2
L × M	19	40	95.6	96.1	102.2
L × H	3	7	103.8	102.9	107.4
M × M	25	47	105.7	103.8	106.2
M × H	36	63	115.2	116.4	111.6
H × H	28	67	124.8	128.8	117.7
Totals	114	233	105.1	105.8	107.2

TABLE VI—Distribution of school success of children in families of selected types.

Type of Parental Mating	No. of Families	No. of Children	Children of each type					
			Total Nos.			Per cent		
			L	M	H	L	M	H
L × L	3	9	4	4	1	44	44	11
L × M	19	40	10	25	5	25	62	12
L × H	3	7		5	2		71	29
M × M	25	47	3	32	12	6	68	26
M × H	36	63	2	40	21	3	63	33
H × H	28	67	2	26	39	3	39	58
Totals	114	233	21	132	80	9	57	34

previously pointed out are still strongly emphasized. The Swarthmore data can be combined with this only by direct addition since these are all distinct families. This furnishes a table of still larger numbers yet telling in all respects the same story. Special comment or discussion of Table V is unnecessary as it would be only to repeat what has already been said in connection with other tables.

We may put these last data into a table of slightly different form showing the distribution of the children of the different types of matings according to class or type of ability of the child. (Table VI).

Again the inadequacy of numbers in the first and third categories is to be noted. No definite conclusions can be based on these two, though seemingly there is indication that low grade parents may have occasionally a high grade child. In general, the percentage of high grade children steadily increases with the higher types of matings. In no case do we get even the suggestion of a Mendelian ratio, which would seem to indicate that our categories do not conform to genetic types or that the genetic factors and their interactions are so complex that the effects cannot be expressed as simple segregations. Presumably both conditions prevail. It is altogether probable that the correlation of children's *SAI's* with the parental *SAI's*, which is a conspicuous feature in every table, involves the expression of some factor or factors in mental inheritance and has, therefore, a genetic foundation, but there appears no clue to an analysis of the data from that standpoint.

Books Received

BOOKS are acknowledged in this column as received, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. As far as space permits, books that contain material of special interest to the readers of the JOURNAL *will be reviewed in later numbers.*

HEALTH ON THE FARM AND IN THE VILLAGE, A Review and Evaluation of the Cattaraugus County Health Demonstration with Special Reference to Its Lessons for Other Rural Areas, *by* C. E. A. WINSLOW, DR. P. H., Professor of Public Health, Yale School of Medicine. Pp. 281. 16 Chapters. Price $1.00. New York, The Macmillan Company. 1931.

The health of our dwindling rural population is being viewed with more and more concern by public healthists. If the drain of the cities on the country is dysgenic, as is more than likely the case, there will be more and more to do in this field of preventative medicine, on less and less promising material. It is safe to say that we have never had an entirely urban civilization, so Dr. Winslow might have peppered and salted these pages with just a trace of a eugenic outlook.

WHITE HOUSE CONFERENCE, 1930, Addresses and Abstracts of Committee Reports, White House Conference on Child Health and Protection called by President Hoover. Pp. 365. Price $2.00. New York, The Century Company. 1931.

The White House Environmental Conference brings in a very inspirational report. After the Navy League rumpus we hesitate to have any thoughts about abysmal ignorance of, or indifference to, heredity displayed by a large majority of the 1,200 experts participating in this conference. "The Children's Bill of Rights," discussed in a previous issue, follows the invocations, welcoming addresses, etc.

COMMUNICABLE DISEASE CONTROL, Report of the Committee on Communicable Disease Control, George H. Bigelow, M. D., Chairman. (White House Conference on Child Health and Protection.) Pp. 288. Price $2.25. New York, The Century Co. 1931.

One of the Committees of the Conference also reports. Here again there appear to be no recognized hereditary

differences in susceptibility! In spite of which this should be a very useful book, as it brings together a great deal of data about a great many diseases.

THE COST OF ENGLISH MORALS, *by* JANET CHANCE, with an introduction by Sir Thomas Horder, Bart., M. D. Pp. 127. Six Chapters. Price, 5s. London, Noel Douglas. 1931.

The *high* cost, we gather: The miracle is, that with so many things wrong we get along as well as we do. The lady would have English morals improved by removing the "repression" on "sex-life," contraception, illegitimacy and abortion.

ANNALS OF EUGENICS. A Journal for the Scientific Study of Racial Problems. Edited by KARL PEARSON, assisted by ETHEL M. ELDERTON. Vol. IV. Parts III and IV. Pp. 150. Issued by the Francis Galton Laboratory for National Eugenics, University of London, Cambridge University Press, 1931.

New facts on heredity in digital anomalies, fertility, birth weight, longevity, cancer and tuberculosis, mental disease.

WORKS OF THE SCIENTIFIC RESEARCH INSTITUTE ON SUGAR INDUSTRY. Pp. 613. Issued by the Ukranian Educational-Experimental Institute of the Sugar Industry, Kiev. 1931.

Begins with a quotation from Lenin as a text to an article on "Ideology of the Bourgoisie in the Domain of Sugar Economies" through "Sugar-beet Agronomy and Breeding," to "Hygiene and Sanitary Technical Conditions in the Problem of Beet-sugar Factory Design." —Try and beet that!

THE ORIGIN AND NATURE OF MAN, An Enquiry into Fundamentals, Reconciling Man's Proud Achievements with Man's Humble Descent, *by* G. SPILLER. Pp. 370. 11 Chapters. Price, 15 shillings. London, Williams and Norgate. 1931.

A very curious situation. Spiller seems to believe (1) that men and apes are much closer together intellectually than generally believed: (2) that all men are intellectually equal; and that for this reason selection and birth rate trends and other matters connected with eugenics are *bunk*. To cap the climax the book is dedicated to Charles Darwin, whose remark about belief only in actual measurement and the rule of three might have been taken to heart by the author.

GENETIC PRINCIPLES IN MEDICINE AND SOCIAL SCIENCE, *by* LANCELOT HOGBEN, M. A., D.Sc., Professor of Social Biology in the University of London. Pp. 230. 8 Chapters. Price 15s. London, Williams and Norgate. 1931.

Apparently a very meaty contribution, but so highly specialized statistically that it might be a question whether general practitioners and social workers will form an idea of what it is all about.

IL PROBLEMA DEMOGRAFICO NELL 'AFRICA EQUATORIALE, Le Cause Della Diminuzione Popolacione. *By* CARLO VALENZIANI. Pp. 109. 9 Chapters. Rome. Comitato Italiano Per Lo Studio Dei Problemi Della Popolazione, Instituto di Statistica E Politica Economica Della Regia Universita di Roma. Serie II, Vol. 1. 1929.

LE LINGUE NAZIONALI DELLA CONFEDERAZIONE ELVETICA E I LORO SPOSTAMENTI ATTRAVERSO IL TEMPO, *by* PAOLA MARIA ARCARI. Pp. 166. Serie II, Vol. II. Rome, 1930.

L'ESPANSIONE DEGLI SLAVI, *by* HASKEL SONNABEND. Pp. 240. Tipografia Failli, Rome. 1930.

Three contributions from the Italian Committee of Population Problems, which perhaps is looking for a place for young Italy to go. With the Slavs expanding through more than twice as many pages as the Africans are decreasing it looks bad for the rapid population-growth enthusiastically championed by Mussolini.

AMERICA'S SEX, MARRIAGE AND DIVORCE PROBLEMS, *by* WILLIAM J. ROBINSON, M. D. Pp. 475. 10 Parts. Price, $3.15. New York, Eugenics Publishing Co.

If Dr. Robinson's books came up to their "ads" they would never get through the mails. As it is, they have no difficulty at all—how the "ads" get by is something of a mystery. Some of his readers must be terribly disappointed, but hope springs eternal, to judge from the number and variety of Robinson's books which have gone into extra editions.

THE INDEPENDENCE OF GENETIC FACTORS GOVERNING SIZE AND SHAPE

In the Fruit of *Cucurbita pepo*

EDMUND W. SINNOTT
Barnard College, Columbia University

ONE of the distinctive characteristics of living organisms is that their various bodily parts have definite and specific shapes. These shapes in such organs as the leaf, flower, or fruit among plants are repeated with such constancy that in most instances they may safely be used to identify species. The development of these shapes must evidently involve rather close correlation in growth between the various parts of a given structure. The actual factors which control these growth correlations are at present almost entirely unknown, but it is obvious that an understanding of them is essential if the science of morphology is to be approached in anything more than a merely descriptive fashion.

The universality with which shapes have been found to be inherited indicates that genetic factors must in some manner be responsible for their determination, but whether this is brought about by a direct control of shape or in some secondary way through the control of quantitative characters is still somewhat uncertain. We know that in many instances the same shape may appear in individuals which are genetically large and in others which are genetically small, and that it may be transmitted essentially unchanged in crosses between these two types. The whole problem, however, of the interrelation between size and shape in inheritance is one on which relatively few careful studies have been made, despite its evident importance from the point of view of morphogenetic analysis. It resolves itself into the question of whether there are genes merely for particular dimensions, bulks, or other quantitative traits, which through their mutual interaction produce shapes, or whether the primary variables are the shapes themselves, controlled by definite shape genes which are entirely distinct from those governing mere extent of growth and which operate directly upon the correlative mechanism whereby growth in one dimension is related, in a specific fashion, to growth in other dimensions of the developing organ.

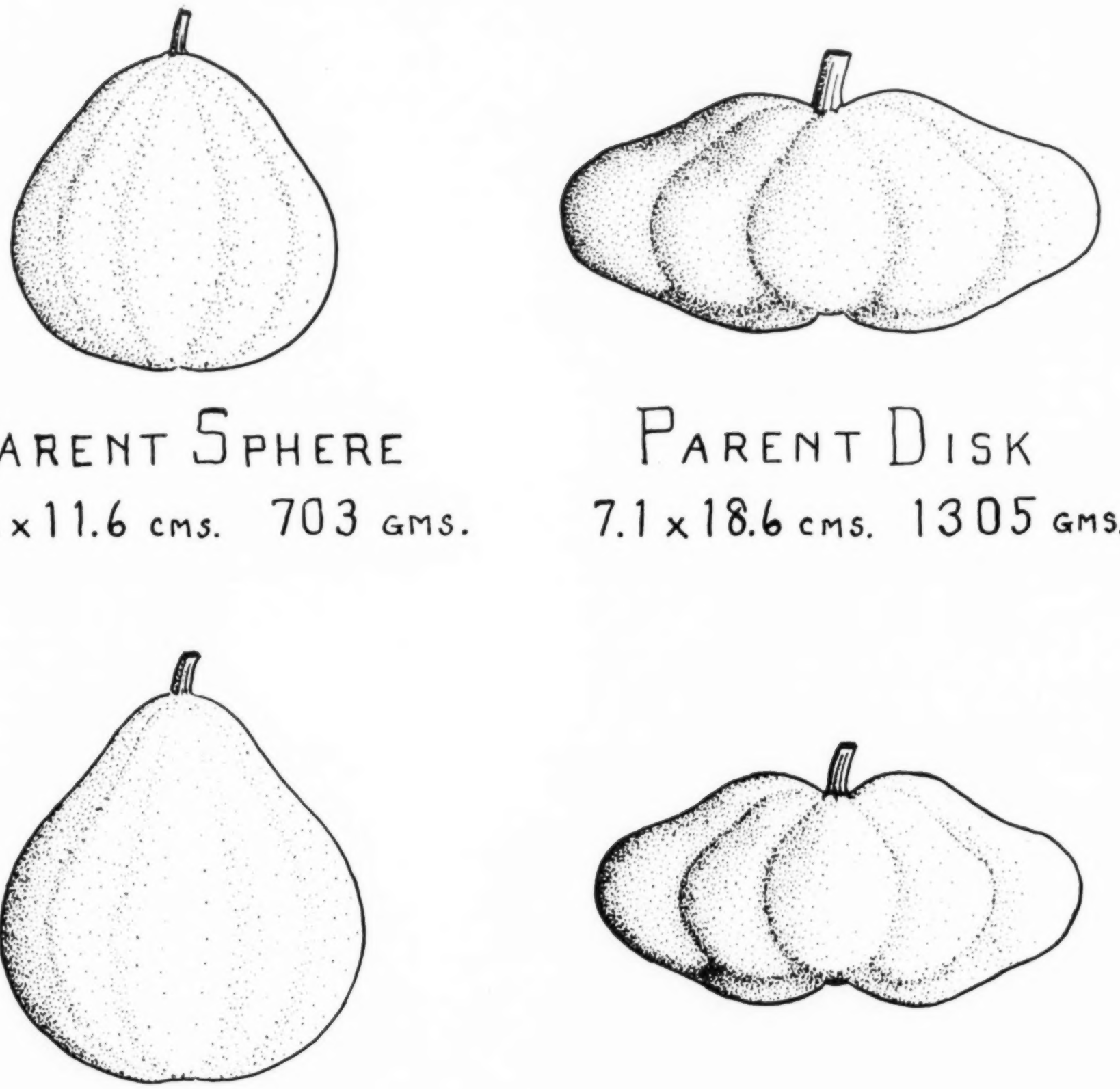
For a study of this problem material must be available in which there are pure races differing markedly in conspicuous and readily measured characters of both size and shape, and in which the inheritance of these traits may be easily studied. Material used by the author in his investigations on the inheritance of fruit shape in *Cucurbita pepo* is admirably suited to a study of this sort. Types have been isolated in essentially homozygous condition in which the shape of the fruit is markedly different, ranging from elongate races in which the length (axial dimension) is five times as great as the width (transverse dimension) to flat ones in which width is more than three times the length. Many of these lines are also sharply divergent in fruit size, some of them having small, gourd-like fruits and others very much larger ones, these differences being definitely characteristic of the lines in question and clearly inheritable. Furthermore, certain of the shape differences show sharp monohybrid segregation in F_2. When such

types also differ genetically in size, it is easy to study the relation between size and shape in inheritance merely by comparing in size the segregating shape types with each other and with the parental ones.

It was thus possible to choose two lines in which the fruit shape was markedly different but inherited in a very simple fashion, and in which fruit size, as measured most conveniently by weight, was also markedly diverse. One of these parental lines, *A* (Figure 3) has essentially isodiametric or spherical fruit. The other, *B* has flat or "disk" shaped fruit about two and one-half times as wide as long. Under ordinary conditions line *A* has a length and width of about 11 cms. each, and line *B* a width of about 18-20 cms. and a length of about 7 cms. Because of the great diversity of shape, direct comparison of dimensions is not very instructive as to size differences, and the contrast in this respect is best indicated by weight. The fruits of line *A* weigh approximately half as much as those of line *B* (702 grams as compared with 1,305 grams).

During two successive seasons crosses between these lines were made, the F_1 generation grown the season immediately following the cross, and each F_2 the season immediately following the F_1. Since the critical comparisons as to size are evidently between the parental spheres and the F_2 segregating spheres, on the one hand, and the parental disks and the F_2 segregating disks, on the other, care was taken to grow fairly large numbers of both pure lines in the two seasons when the F_2 generations from crosses between them were grown, and to place the pure types and the F_2 segregates under as nearly similar conditions as possible. On one of the years, the two parent types were grown in rows alternating with the F_2 plants. Although these two lines have been grown every season for many years, the data for the present study are taken entirely from the plants belonging to them which were grown in these two seasons. During these years, 120 plants of line *A* (small and sphere shaped) were grown to maturity, 167 plants of line *B* (large and disk shaped), and 205 F_2 plants. In all, 52 F_1 plants were grown. When the fruits were ripe, the best developed one from each plant was chosen for record. It was weighed to the nearest gram immediately after picking and was then carefully split in two along its longitudinal axis from stalk to corolla scar. One of these halves was laid, cut surface downward, on a sheet of heavy paper and its outline traced on the paper. From this profile the dimensions could be measured more easily and accurately than by the use of calipers. This method of measureent has been used in our work for the past five years. The data for length, width, and weight of the pure lines, the F_1, and the two segregating groups in the F_2 (spheres and disks) are given in Table I.

The inheritance of shape in a cross of this sort has been described previously by the author.[1, 2] The disk shape is completely dominant over the spherical one and there is a simple monohybrid segregation in F_2, approximately ¾ of the plants having disk shaped fruits and ¼ spherical ones, both types reproducing the parental shapes rather closely. In Figure 4 are plotted the shape indices for the line *A* and line *B* plants used in this study and for the F_1 and F_2 generations derived from crosses between these. The index in each case was determined by dividing the longer of the two dimensions by the shorter, and the indices plotted logarithmically as previously described.[2] An index of 2W describes the fruit as twice as wide as long, one of 2L twice as long as wide, and so on. Indices are plotted in both directions from 1 (the isodiametric point), the flat or disk types to the right and the elongate types to the left. In Figure 4 it will


PARENT SPHERE
11.2 x 11.6 cms. 703 gms.
PARENT DISK
7.1 x 18.6 cms. 1305 gms.
F2 SPHERE
13.7 x 12.7 cms. 1026 gms.
F2 DISK
6.8 x 16.8 cms. 1036 gms.

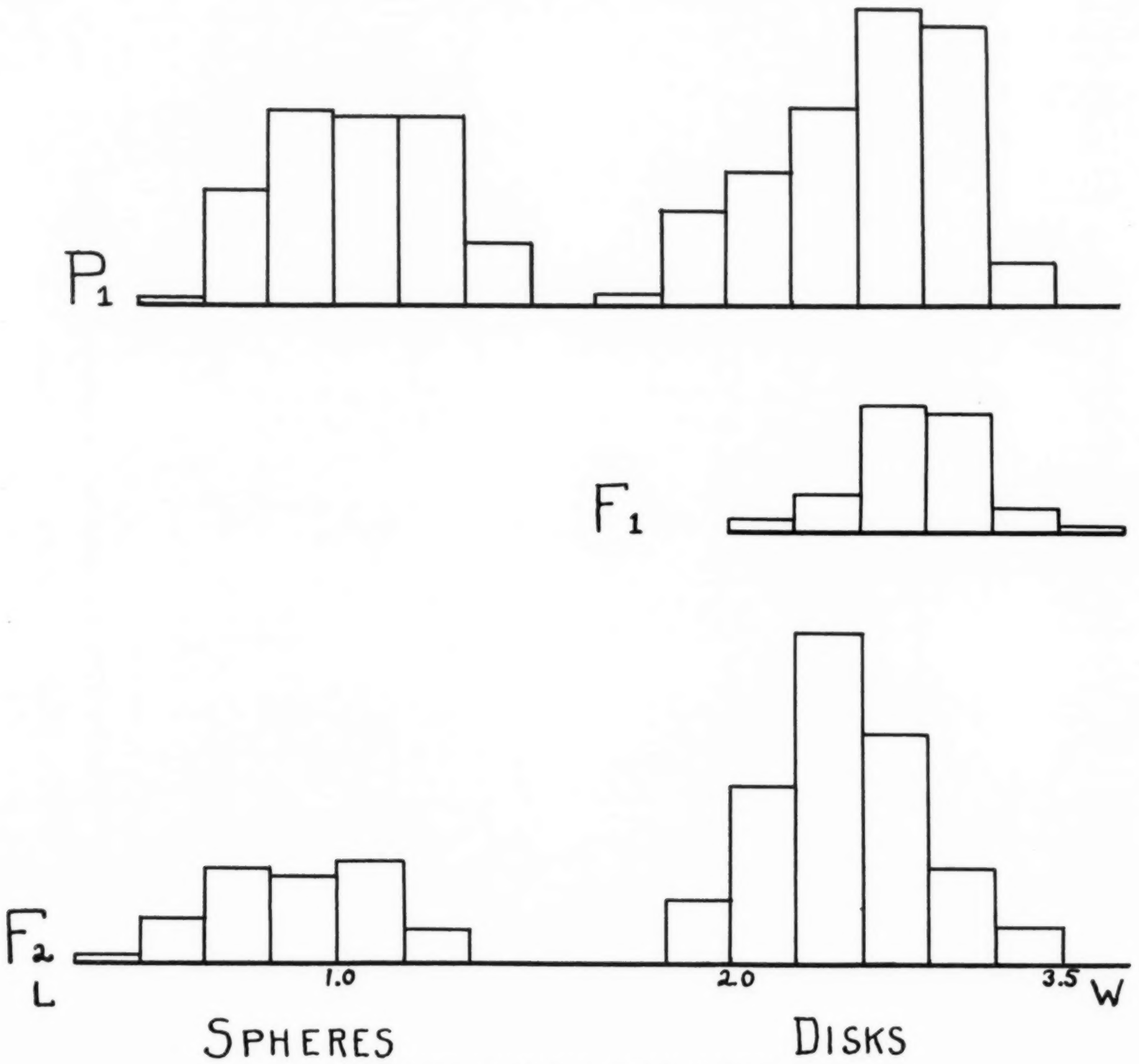
FRUIT SHAPE CONTRASTED

Figure 3

Above, fruits of line *A* (left) and line *B* (right), their dimensions proportional to the means of the plants of these two lines used in this investigation.

Below F_2 spheres (left) and F_2 disks (right) from a cross between *A* and *B*, the dimensions of the fruits proportional to the means for the two segregating classes. Note that in the F_2 the spheres and disks are of approximately equal weight, while in the parent strains they differ greatly. This shows the independence in inheritance of shape and weight factors.

be seen that the group of line *A* plants fall on both sides of 1 but have a mean approximately on the isodiametric point, and that the line *B* plants range from a little less than 2W to about 3.5W with a mean of about 2.5W. The F_1 plants are clearly disks with a range and mean index close to those of line *B*. In the F_2 there is a sharp segregation into spheres closely resembling line *A* (though slightly more elongate), and disks, closely resembling line *B* and the F_1. A monohybrid ratio is essentially obtained (147:58) although there is a slight excess of the recessives, the theoretical expectation being 153.75:51.25. There is thus a



SHAPE INDICES COMPARED

Figure 4

Shape indices of parents, F_1 and F_2 in a cross between lines with spherical and with disk shaped fruits. Fruits longer than wide plotted to the left of 1.0 (isodiametric shape), and those wider than long to the right of it.

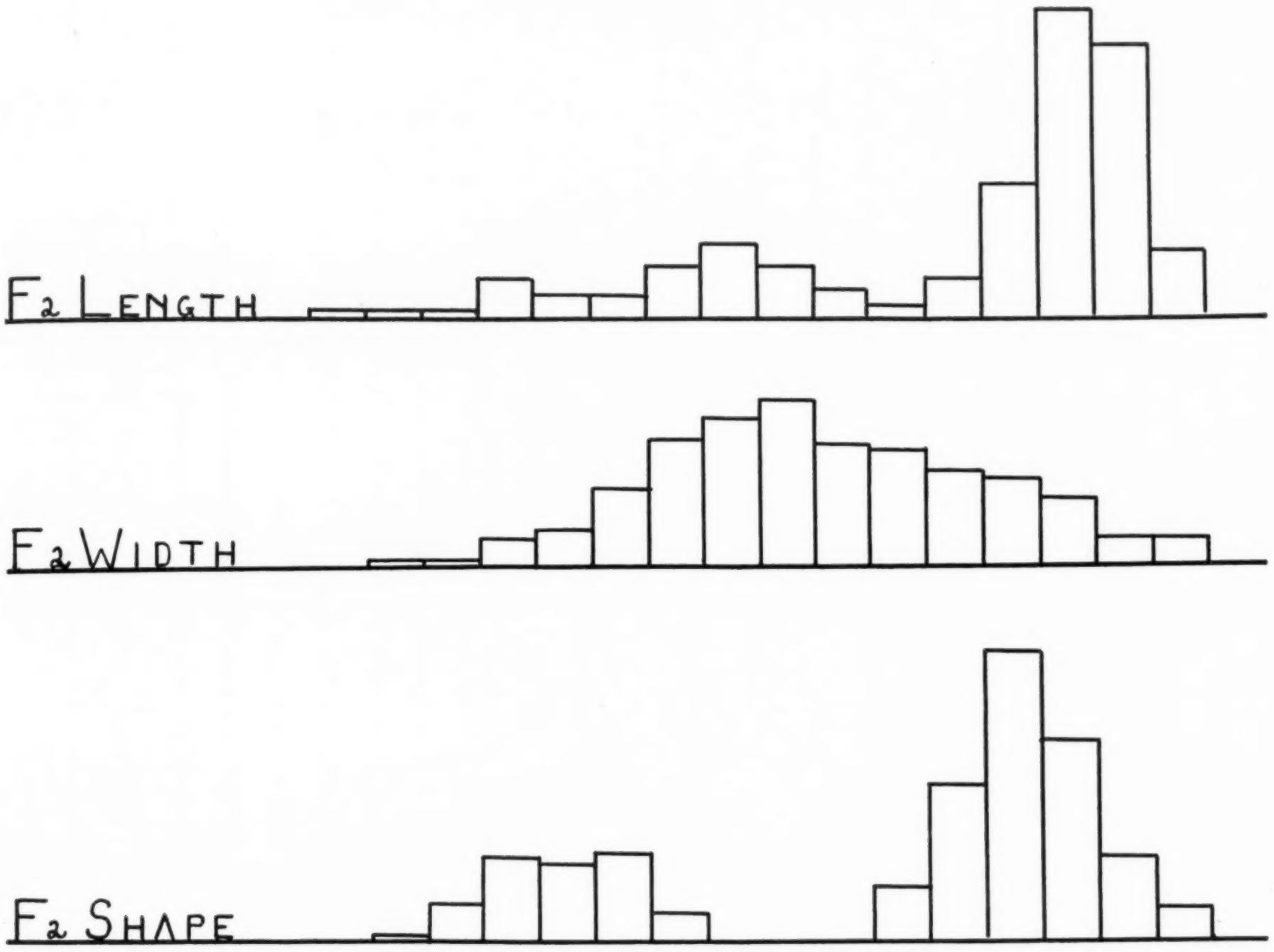
difference of 6.75 ± 4.128 from expectation, but this difference, being only 1.635 times its probable error, is evidently not significant.

Dependence of Shape on Size

Fruit shape, whatever may be the factors which control it in this case seems to be inherited in a very simple fashion and is evidently determined by a single genetic factor. An excellent opportunity is here presented, through the possibility of comparing the size characters of the segregated spheres and disks with each other and with the corresponding parental types, of determining whether or not there is a dependence of shape on size in inheritance. The essential data are presented in Table I.

The F_1 in its dimensions is not markedly different from the parent disks of line *B*, but is slightly shorter and wider. Its mean weight is also approximately that of line *B*.

The essential data for a comparison between parental and F_2 spheres and disks is set forth graphically in Figure 3, the dimensions of the four fruits outlined being proportional to



SEGREGATION OF SHAPE FACTORS

Figure 5

F_2 segregation for length, width, and shape index in a cross between lines *A* and *B* (sphere × disk). Length and width in 1-centimeter classes, shape as in Figure 4.

the mean dimensions for the four respective types as shown in Table I. It will be evident at a glance that the F_2 spheres are markedly *larger* than the parental spheres. For the F_2 the mean length is 13.72 cms., the mean width 12.69 cms. and the mean weight 1,025.86 gms., as opposed to 11.23 cms., 11.62 cms. and 702.50 gms. for the parent spheres. These differences are in every case significant ones, that for length being 2.499±.226 cms., or 11.061 times its probable error; that for width being 1.073±.157 cms. or 6.856 times its probable error, and that for weight 323.362±32.352 gms., or 9.995 times its probable error.

A precisely opposite relationship is manifest between the parental disks and the F_2 disks, the latter being markedly *smaller* than the former instead of larger, as in the case of the spheres. For the F_2 disks the mean length is 6.76 cms., the mean width 16.80 cms., and the mean weight 1,035.71 gms., as opposed to 7.06 cms., 18.61 cms., and 1,305.70 gms. for the parent disks. These differences are also all significant, that for length being .305±.070, or 4.343 times its probable error; that for width being 1.815±.198 or 9.184 times its probable error, and that for weight being 269.376±29.308 gms., or 9.191 times its probable error.

It is particularly noteworthy that the F_2 spheres and disks, although segregating sharply for shape, are essentially the same in size (1,026 as compared with 1,036 gms., respectively), the difference between their mean weights being thus only 9.852±36.883 gms., and thus only .267 times its probable error and clearly without significance; whereas the differ-

ence in weight between the two parental types was 602.590±23.338 gms., or 25.820 times its probable error.

It is thus evident that although shape in this pedigree seems to be controlled by a single mendelian factor, weight is inherited in a typical blending fashion. The F_1 indeed is heavier than the mean between the two parent types, but this is presumably due to hybrid vigor. The essential point is that the F_1 shows no increase in the variability of its weight as compared with the parents but that the weight variability of the F_2 increases markedly. The coefficient of variability for weight of the entire F_2 taken together is 35.102±1.306%, this being an increase of 11.895±2.076% over the F_1, and since this difference is 5.730 times its probable error it seems clearly significant. These facts suggest that weight in this cross is controlled by a series of multiple factors. Whatever our precise factorial interpretation of the inheritance of shape and weight, however, the fact is clearly patent that these two traits are inherited entirely *independently* of each other.

Dimensional Factor Hypothesis

It may be objected that the real factors which are concerned in both these traits are dimensional ones; that one set controls, let us say, the length of the fruit and the other its width; and that these, through their interrelations, determine not only fruit size but fruit shape as well. It is instructive in this connection to study the inheritance of these two dimensions by themselves. The F_2 distribution for each, in one-centimeter classes, is set forth in Figure 5 and these may be compared with the distribution of the F_2 shape indices directly below. In length, the F_2 shows segregation into something resembling a 3:1 ratio, but this is by no means so clear as is the case for shape, and the range considerably exceeds that of the parents. For width, however, the F_2 shows a smooth curve with a mean approximately intermediate between those of the two parent types. From a consideration of dimensions alone, therefore, we should be forced to conclude that a single factor was concerned in the inheritance of fruit length, but a series of multiple factors in the inheritance of fruit width. With this rather difficult hypothesis we may contrast the much simpler one previously proposed, namely that shape is controlled by a single "shape" factor of some sort which may express itself in fruits of any size, size presumably being governed by a series of quantitative factors, independent of and different in character from the shape factor. The pronounced negative correlation between length and width which is always found in the F_2 of crosses between types differing in fruit shape makes still more difficult an interpretation of shape inheritance on the basis of dimensional factors.

The present hypothesis assumes that in fruit development in Cucurbita there are only two classes of factors, (1) those governing volume, bulk or weight and presumably effective through their control of the amount of material at the command of the growing fruit, and (2) those governing shape, presumably effective through their control of growth correlation. The actual dimensions of a given fruit are thus to be regarded as merely the necessary resultants of the interaction between these factors for volume and the factors for shape which mould the material provided by the volume factors; and dimensional factors, so often assumed to exist, are apparently absent. Indeed, it is a question whether in most organisms such dimensional factors are very common. Certainly in the present instance we can most simply explain the facts without postulating their existence at all. The whole problem of how a given plant organ attains its mature size and shape of

course involves a far more complete knowledge of developmental processes than we at present possess.

Summary

1. To determine the relationship between size and shape in inheritance, two pure lines of *Cucurbita pepo* differing markedly both in fruit size and fruit shape were crossed. One of these has a small, spherical shaped fruit and the other a large, disk shaped one.

2. In this cross there is a sharp monohybrid segregation for shape into ¾ disks and ¼ spheres in F_2.

3. The F_2 spheres are significantly *larger* than the parental spheres, the F_2 disks significantly *smaller* than the parental disks, and the F_2 spheres and disks essentially *equal* in size.

4. The variability in weight of the F_2 is significantly higher than that of the F_1.

5. These facts suggest that there is here a single factor for shape and a series of multiple factors for weight, and that factors controlling shape in this species are independent of, and different in character from, those controlling total size or volume.

6. Evidence is presented that particular dimensions of the fruit are merely resultants of the interaction of these shape and volume factors, and that genetic factors directly controlling dimensions do not exist in this material.

Literature Cited

1. Sinnott, Edmund W. 1922. Inheritance of fruit shape in Cucurbita Pepo. *Bot. Gazette* 74: 95-103.

2. Sinnott, Edmund W. 1927. A factorial analysis of certain shape characters in squash fruits. *Amer. Nat.* 61:333-344.

TABLE I—Data for the distribution, mean, and coefficient of variability for fruit length, width, and weight of the parent spheres and parent disks, the F_1, and the segregating F_2 spheres and disks.

	LENGTH (Class centers in cms.)																MEAN	C. V.
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
Parent Spheres				2	6	27	39	25	16	5							11.225 ± .079	11.412 ± .505
Parent Disks	5	36	74	48	4												7.060 ± .044	11.979 ± .449
F_1	3	15	27	7													6.731 ± .071	11.333 ± .754
F_2 Spheres					2	2	5	9	13	9	4	4	7	1	1	1	13.724 ± .212	17.421 ± 1.121
F_2 Disks	12	49	56	24	5	1											6.755 ± .055	14.511 ± .582

	WIDTH (Class centers in cms.)																		MEAN	C. V.
	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			
Parent Spheres		6	15	32	39	22	6												11.617 ± .074	10.377 ± .448
Parent Disks					1	4	7	14	19	14	18	23	19	20	16	7	5		18.611 ± .145	14.943 ± .566
F_1							1		3	5	7	13	12	8		2	1		19.192 ± .173	9.646 ± .628
F_2 Spheres	1	1	4	6	10	16	15	5											12.690 ± .138	12.261 ± .763
F_2 Disks			1		4	7	12	25	22	21	17	16	12	5	5				16.796 ± .134	14.350 ± .574

	WEIGHT (Class centers in GMS.)																				MEAN	C. V.
	350	450	550	650	750	850	950	1050	1150	1250	1350	1450	1550	1650	1750	1850	1950	2050	2150	2250		
Parent Spheres	4	7	25	23	30	17	8	4	2												702.500 ± 10.363	23.959 ± 1.103
Parent Disks		1	6	4	9	4	15	11	27	10	14	11	13	11	9	9	7	3		3	1305.090 ± 20.912	30.701 ± 1.218
F_1				1	1	4	3	5	1	8	5	8	5	3	5	3					1334.615 ± 28.966	23.207 ± 1.614
F_2 Spheres		3	3	6	4	7	8	3	6	3	7	4	1		1	2					1025.862 ± 30.648	33.731 ± 2.336
F_2 Disks	1	6	10	9	20	16	11	17	13	11	5	5	9	9	1	2	1	1			1035.714 ± 20.520	35.615 ± 1.562

Asiatic and American Centers of Cultivated Plants

RUSSIA today has the most extensive program of plant improvement and crop diversification in the world. The five-year plan is not altogether mechanical and economic. It includes not only entirely rearranging the mechanism of agricultural production, but a virtual remaking of many crop plants. Whether the crops or the agricultural technique of so vast a region can be materially altered in five years, or twenty-five, remains to be

seen. Nevertheless the world is being combed, and Russia is being intensively studied with a view to the development of new crops to aid Russia to economic independence. With a range of climate from the Arctic to the Tropical, plants suited to almost any conditions may be of possible value in some part of the Soviet Union.

Thus even the recently announced policy of suspending the pursuit of "pure science" in Russia, and limiting scientific endeavors to "practical" researches, unless applied with suicidal narrowness, would hardly be expected to affect the program of plant exploration which has elicited several interesting contributions in recent years.

Crop improvement in Russia is under the direction of the Institute of Plant Industry, whose genial and enthusiastic director, Dr. N. I. Vavilov, has recently added two new chapters to his theory of the origin of cultivated plants, in the form of preliminary reports of two expeditions, one to Central Asia and one to Central America.

Vavilov's theory of the origin of cultivated plants postulates that the endemic habitat of a cultivated plant is to be found in the region where the wild species shows the greatest diversity. Granting the soundness of this reasoning Vavilov has shown that many of the European crop plants originated on the South-western slopes of the Himalayas. In northwestern India and Southeastern Afghanistan are found the most diverse forms of the soft and club wheats, rye, peas, lentils, vetches, beans, flax, carrots, and some of the cabbage relatives. Secondary areas of diversity for some of those species are found in the Mediterranean Basin and in Abyssinia.

Since the southern slope of the Himalayas was so rich in endemic forms of cultivated plants it has been suggested that the other side of this great range might have an interesting story to tell. In 1929 Vavilov traversed this area, and the results have recently been reported.* An extended abstract in English makes the results available to the English-speaking world.

The difference in the two sides of the Himalayas in its crop plants is evidently striking. On the Northeast slope the economic flora is much smaller, and the range of variation is very much less. On the Ancient Oases of Kashgar, Yarkand and Khotan, which represent isolated agricultural regions of great age the existence of forms recessive to the commonly grown varieties further West is noted. This is believed by Vavilov to be a characteristic of plant and animal varieties in isolated regions and on the border of distribution. Only flax and apples show many wild relatives and a bewildering diversity of form, suggestive of their being endemic to this region. These forms are undoubtedly of great promise to the plant breeder.

The following year Vavilov visited North America and Central America, and this trip has been reported in a second contribution to the same Journal.† He visited only the more northern centers of agriculture in America, in Mexico and Guatemala. Here he found the type of flora and the diversity of characters of the kind he postulates in a cradle of agricultural civilization—cultivated forms growing side by side with wild forms of the same or very similar species. On the basis of this diversity he is inclined to award the Mexican-Guatemalan tablelands primacy over Peru as an area of endemic agriculture in America. In this he disagrees sharply with O. F. Cook,‡ who has spent much more time in Mexico

---

* Vavilov, N. I. The Rôle of Central Asia in the Origin of Cultivated Plants. *Bulletin of Applied Botany, of Genetics and Plant Breeding.* 26:1-44. 1931.

† Vavilov, N. I. Mexico and Central America as the Principal Centre of Origin of Cultivated Plants of the New World. *Ibid.* 26:135-199. 1931.

‡ O. F. Cook, Peru as a Centre of Domestication. *Journal of Heredity*, 26:33-46 and 95-110. 1925.

and Guatemala, and who has also had the advantage of first hand study of the Peruvian centre. Certain it is that these regions of agricultural origins in America, which are also one of the centres of the beginnings of Agriculture in the world, are teeming with forms of the greatest value to the plant breeder. Much of our North American agriculture is carried over with as little modification as possible from Northern Europe. One of the great needs today is a deliberate, carefully reasoned, reorganization and diversification of agricultural crops and practices more in keeping with actual needs and conditions.

New crops to fill new and different needs is perhaps the ultimate solution, and the only solution of much of the present agricultural crisis. Vavilov shows where much material for the development of such crops lies ready to hand, and in other parts of the world other centres await further study and utilization.

A Revised Edition of Walter's "Genetics"

WALTER, H. E., Genetics. Edition 3. Pp. XXI + 359. New York, Macmillan, 1930.

PROF. H. E. Walter's well known volume on Genetics has appeared in a third revised and somewhat enlarged edition. This book has long performed a useful service in providing the student with a clear and well organized presentation of the fundamental principles of heredity. In the nearly ten years that have elapsed since the issue of the second edition, discoveries in genetics have been coming thick and fast. In this field, therefore, a book soon becomes out of date.

For the most part, the present volume follows the plan of the previous editions, but it contains much new material. In a future edition, which we hope will appear in the course of a few years, we might suggest that Dr. Walter consider placing the chapter on The Carriers of the Heritage in an earlier part of the book, as it was in the first edition. If, when the student has become acquainted with the elementary principles of segregation, he is led to see that this process follows logically from what is known of the behavior of chromosomes in synapsis and maturation, he would be in a better position to grasp the factor hypothesis, the Mendelian interpretation of blending inheritance, and other Mendelian phenomena. It is precisely the relation of the cellular phenomena to Mendelism that the author fails to make clear to the student. Synapsis is treated in a very cursory way, and its fundamental relation to Mendel's law is not alluded to at all. The only discussion of its relation to heredity is in connection with the subject of linkage.

While the author has fallen down a bit in his exposition of the cytoplasmic basis of heredity, his presentation of the subject matter throughout the volume is usually simple and clear. We hope that the last edition of *Genetics* will meet the approval with which the previous editions have been received.

S. J. HOLMES.

Physiology of the Green Plant

PLANT PHYSIOLOGY, by E. C. MILLER, 900 pages, $7.00. McGraw-Hill Book Co., New York. 1931.

A TEXT for advanced classes in plant physiology, but much more, for it summarizes most of the work on the subject up to 1931 making available to research workers much material which has heretofore been very widely scattered. The author has, of course, interpreted the subjects in the light of his own wide experience and has included some of his own unpublished work to make it still more valu-

able. The literature of plant physiology is well covered in extensive lists of citations at the end of each of the eight chapters. It is easily the outstanding book on the subject in any language.

The chief criticism of a book such as this is that is is not complete enough even though containing 900 pages of well-digested material. No author can hope to cover all the literature, especially in the first addition, and this is true here. Two examples will suffice. On page 376 five methods of measuring leaf surfaces of living plants are given. The reviewer has used three methods this summer none of which are mentioned: (1) the leaf-product method of Livingston and associates (2) a matching method in which pasteboard forms of measured area are matched with leaves on the plants and (3) the planimeter method whereby an adjustable platform is set under the leaves. On pages 691-692 the lack of data on the lateral movement of water in plants is pointed out, but references to the work of White on lateral movement of water in the strawberry is not cited. The literature is, however, so extensive that it is impossible to cover all work.

The geneticist and breeder will find this book invaluable because of the many references and the great amount of data on the different physiological responses to conditions by different plants. Although genetics as such is scarcely mentioned, the book is a well-organized reference work on genetic differences in plants from the physiological viewpoint.

GEO. M. DARROW.

Soviet Factory Fables

NEW RUSSIA'S PRIMER. The Story of the Five-Year Plan, *by* M. ILIN, translated by George S. Counts and Nucia P. Lodge. Boston, 1931.

EVERYONE has heard of the five-year plan by which the Russians expect to transform their country into Paradise. To many of us it has seemed a task impossible of realization in five times five years, but to the Russians it is a very real possibility.

Until the revolution the Russians seemed to possess a perfect immunity to the machine idea. Apparently, however, it was not a true immunity but rather freedom from exposure, for since the idea gained entrance to the U. S. S. R. it has become pandemic, spreading like a plague. Factories, factories, and still more factories are projected, and even agriculture is envisaged as a colossal food factory. Compared with Russian Agricultural plans our own modest efforts, to make two blades of grass grow where but one grew before, are trivial. The mere thought of converting a rather primitive agricultural society into something surpassing a modern industrial organization is staggering yet the Russians hope to accomplish just this and to do it in five years.

They are bringing to this problem not only the delightful naiveté of the imaginative child, but the consummate skill of the practised propagandist. Nothing is being overlooked that may contribute to the success of this gigantic undertaking. Workers, at present, may be underfed and overworked, they may be ill-clohted and ill-sheltered, but in the success of the five-year plan they are shown their reward. Even the children are enrolled in the program.

Unfortunately most of our knowledge of Russian aims and methods reaches us only through the medium of a possibly prejudiced or inadequately informed press. The picture of Russia that we have seen is one where the individual is sacrificed for the benefit of the State; there has been very little evidence that the Bolsheviks ever thought much of individuals as separate entities with diverse desires. However, we now have an authentic translation

of the *New Russia's Primer* which shows among other things that the ultimate aim of all this frantic industrialization is to make life more satisfactory for the individual.

Addressed to children under 12 years, the object of this little book is to arouse their enthusiasm for the five-year plan by pointing out a few activities wherein even a child may contribute his worthwhile mite to the realization of the glorious future. Doubtless Russian youngsters are no less adept than their capitalistic cousins in persuading papa to trade in the old car, or possibly tractor, or whatever is the Russian equivalent of our capitalistic method of progress. Considering these children are twelve-year olds or younger, the State has high expectations for them, but then high expectations seem to be the distinguishing characteristic of those in control of Russia. Just a few of the things assigned to the children are listed below:

> To discover beds of lime and phosphorous.
> To sort and treat with insecticide one hundred per cent of all grain used in kolkhozes and on farms of your parents.
> To plant ten trees each in five years; to create Pioneer forests of seventy-five million trees.
> To destroy bedbugs, roaches, and flies in five hundred thousand houses. Each troop should clean up ten houses.
> To teach the illiterate to read and write. Each troop should endeavor to wipe out illiteracy in its region.

As a reward for doing well these, and many other similar tasks, the children are promised a complete metamorphosis from the hard labor and squalor of their present grub existence, to the carefree and beautiful life of the adult butterfly. Not only will there be a great reduction in the hours of labor, but the very places in which they live are to be redesigned. The Civic Centers of their cities of the future are not to be parks, markets or public buildings, but roaring factories from which broad avenues radiate to the residential belt where "Each dwelling will turn toward the sun in order to get as much of its light as possible." Could anything be more pathetically child-like? We, who have had factories for so long, find it hard to realize that to the Russians they are still gaudy toys that clang, clang, clang, belch smoke, and turn wheels. Yet these factory worshippers are disciples of Stuart Chase! It seems strange to us that the Russians are making such a fetish of factories, but apparently they are thoroughly "sold" on the idea that complete industrialization spells happiness. They believe that State ownership, instead of capitalistic ownership, of machines makes the difference between Heaven and Hell, and however much one may feel that they are chasing a will o' the wisp, one cannot help admiring their determination to follow their convictions.

The story of the five-year plan is written by an engineer, but an engineer far more poetical than practical, and its parables resemble nothing so much as the old Russian fable of "Mr. Bear squash-you-all-flat." After a series of terrible struggles everything comes out alright in the end due to a combination of magic and fairy godmother intervention. Everything is considered, from the production of food, the trials of the kitchen, the operation of mines, factories and electric plants, to the manner in which the worker is to pass his hours of leisure in the evening, protected from the riotous sounds of children at play. It is a complete plan.

One cannot help feeling a bit wistful while reading this Russian industrial fairy tale, for one recaptures early childhood days when great things were afoot and insurmountable obstacles were miraculously thrust aside. Our feeling, on finishing this primer, is the same sort of amused tolerance we have for the ambitious child who undertakes an impossible task with the faith that sometimes moves mountains, but too often leads only to disillusionment.

J. H. Kempton.

Rabbit Genetics

THE GENETICS OF DOMESTIC RABBITS, A manual for students of Mammalian Genetics and an aid to Breeders and Fur Farmers *by* W. F. CASTLE. 31 pp. + 13 plates. Harvard University Press, Cambridge, Mass. 1930.

THE SCIENTIFIC ASPECTS OF RABBIT BREEDING, *by* JAMES *N.* PICKARD and F. A. F. CREW. Pp. IX + 122; 12 plates. Watmoughs Limited, Idle, Bradford, and London. 1931.

THESE two useful books appearing almost simultaneously in England and in the United States are primarily addressed to the practical breeders and fanciers of rabbits, but they should find places as well on the shelves of the increasingly large number of persons who use rabbits as experimental material. A great deal has been learned during the last thirty years about the genetics, the morphology, the embryology, and the physiology of reproduction in rabbits, and with the rapid growth of the rabbit breeding industry in England and America since the war, there was great need for such summaries of the new knowledge as these books together provide.

Professor Castle's book is a concise statement of the established facts of heredity in rabbits. The chief variations in coat color, pattern, and fur characters are described, and the genetic formulae for the varieties as known to the fanciers are given. A feature of the book is a set of thirty-nine excellent photographs of the principal varieties, well reproduced in half tone. There is a brief bibliography, listing general works in which more detailed references are available.

The book by Dr. Pickard and Professor Crew is a more complete exposition of the biological basis of rabbit breeding. It includes chapters on the histories of the breeds, on the physiology of reproduction in relation to breeding practices (using Hammond's valuable "Reproduction in the Rabbit" as a principal source), on growth, nutrition, and management. The chief space is devoted to the heredity of color, pattern, and fur characters, and the breeder is given a brief course in Mendelian heredity with illustrations of segregation, independent assortment, and linkage derived from experiments with rabbits. Detailed directions for making progeny tests are given which any breeder should be able to follow. There is a table of the genes identified in the rabbit, a glossary, a fairly complete bibliography, and a good index. The needs of the practical breeder seem to have been kept constantly in mind, and the information given seems to be both reliable and clearly stated.

L. C. DUNN.

Modern Plant Breeders Go "Back to the Wild"

"Back to the wild" is a motto o'ten observed by plant breeders of small fruits in the United States Department of Agriculture. They have found that crossing established domestic varieties with some of the foreign and native wild types often gives the resultant progeny certain hardy characteristics, which make it resistant to many of the common plant diseases.

Breeding among such fruits as strawberries, raspberries, and similar small fruits has become an important branch of the work of the department, and many investigations in small-fruit breeding are under way, in cooperation with State experiment stations.

Many foreign plants are brough to America for this work, and although many of these are not good varieties in themselves they often have desirable characteristics. When they are crossed with other plants they frequently transmit these characteristics. Red raspberries brought from China and other wild imported fruits are being used for breeding work with some of the well-known American varieties.

U. S. Dept. Agriculture.

AN INBREEDING EXPERIMENT WITH POLAND CHINA SWINE

HUGH C. MCPHEE, E. Z. RUSSEL
and JOHN ZELLER

Bureau of Animal Industry, U. S.
Deparement of Agriculture

THE experiment which has furnished the data for this report is a part of an investigation initiated by the Bureau of Animal industry at Beltsville, Maryland, in the spring of 1922. The primary object in view was to produce true breeding strains of swine with known characteristics for use in critical research in genetics and nutrition. The original plan was to develop at least two unrelated inbred strains in each breed used and to make crosses at a later date between both the inbred strains of the same and of different breeds.

The start was made in the fall of 1922 when 6 gilts and their litter brothers were selected to start inbred lines in the Poland China breed. The following year selections of foundation stock for inbred lines in the Tamworth and Chester White breeds were made. This report concerns only the Poland China part of the investigation.

Four of the six gilts selected as foundation stock were sired by Model Timm 470315. Two of these were litter mates and the other two were half sisters. Thus gilts Nos. 110 and 116 were litter mates and Nos. 101 and 103 were by the same sire as 110 and 116 but out of different dams. Nos. 108 and 111 were sired by Chicago 454323 and out of Model Bobette 1st 1147938. The next season three more gilts were added to the foundation stock. Two of these were by Model Timm and the third by Chicago.

This foundation stock was slightly inbred* within four generations back of sire and dam due to the occurrence of Model Flossmoor 754382 as a common ancestor. The dam of Model Timm, both grand dams of Sunnyside Flossie 1147948 (dam of 110 and 116), the dam of Model Bobette 1st and the grand dam of Chicago on his dam's side was Model Flossmoor. The inbreeding of sows 108 and 111 was 6.25 per cent and of 110 and 116 was 12.5 per cent. The mating of brother with sister for a single generation would raise this latter figure to 32.8 per cent and two generations of brother-sister mating would result in the coefficient 41.8 per cent. The coefficient of relationship between the 108-111 group and the 110-116 group was 24.39 per cent or roughly that which exists between half brothers or half sisters.

Some of the females failed to contribute much to the investigation and were dropped from the herd at an early date. Sows 110, 111 and 116 were the most prolific producers, having farrowed about 70 per cent of all first generation pigs. The other five sows proved to be inferior producers.

The type of mating employed has

---

*The coefficient of inbreeding used here is that given by the formula $F_X=(\frac{1}{2})^{n+n'+1}(1+F_A)$ in which F_X is the desired coefficient, F_A the coefficient of inbreeding of a common ancestor and n and n′ the respective number of generations behind the sire and dam of the individual that the common ancestor occurs. The coefficient of relationship is given by the formula:

$$R_{XY}=\frac{[(\frac{1}{2})^{n+n'+1}(1+F_A)]}{\sqrt{(1+F_X)\ (1+F_Y)}}$$

been rather uniformly brother with sister. Whenever possible litter mates were selected but it frequently happened that non-litter mates with the same parentage had to be used. The original plan was to select a boar and two gilts (litter mates) as parent stock for each generation. It soon became apparent that such a procedure is a very risky one and it was amended to include two or three boars and three or more sows in each generation of inbreeding.

The matter of a satisfactory check in an experiment of this kind offers some difficulties. The use of double mating cannot be relied upon because of the difficulty of obtaining both inbred and crossbred pigs in the same litter. A modification of this plan, the breeding of the inbred stock to noninbred stock or the breeding of the female in one inbred line to boars of another inbred line is probably more satisfactory. Another method is to check results against those obtained in a noninbred group raised under similar conditions. The latter is the method used in the present experiment, not because it was considered the best but because of necessity.

Birth Weight Decreases

Mean birth weight was slightly lower in the inbred than in the noninbred lots. The data presented in Table I show that difference in this respect between the first generation inbreds and the control stock was 0.41 ± 0.036. This appears to be a significant difference. The second-generation pigs did not, however, show a further decrease in mean birth weight. In this connection it must be remembered that the first generation pigs were approximately 33 per cent less heterozygous than the foundation stock of five generations back instead of 25 per cent which would have been the case if the parents had been noninbred. Likewise the second-generation pigs were approximately 42 per cent less heterozygous than the foundation stock.

The decrease in birth weight is a somewhat different result than has been obtained by others in experiments of a similar nature, particularly in the Delaware inbreeding work. Hays[8] reports that inbreds were slightly, but not significantly, heavier at birth than the crossbreds which were born in the same litters. In work with other breeds also the authors have not observed such a marked decrease in mean birthweight of the first generation pigs. It appears probable, therefore, that this line of Poland China swine was particularly sensitive to inbreeding. Other strains of breeding might fail to show any decrease at all in birth weight in the first generation of inbreeding.

Size of Litter

The mean litter size in the first generation was 6.75 ± 0.34 and in the second generation 4.26 ± 0.48. The average in the noninbred control stock was 7.15 ± 0.19. These averages include all pigs farrowed whether dead or alive. The slight decrease in litter size among the first generation pigs is not of any consequence. The further decrease of 2.49 ± 0.59 in the second generation is, however, great enough to be significant. The most decisive causal factor concerned in this decrease was probably prenatal mortality, the evidence for which consisted of an increase in percentage of stillborn and very weak pigs.

The effect of inbreeding on litter size in this strain of swine is more drastic than observed in other similar experiments at Beltsville. As a matter of fact, in some strains it appears that size of litter is only slightly affected in the early generations. Craft[4] has reported that in his inbreeding investigations with Duroc-Jersey swine the inbred group averaged in the first two generations more pigs per litter than the outbred group. He employed half brother-sister mating and, therefore, the reduction in heterozygosity brought about was roughly the same as accomplished by one generation in the present experiment.

With the brother-sister type of mating a decrease in size of litter or a shift in sex ratio gives rise to difficulties in propagation. It is necessary to

select at least one boar and one or more females to breed from for the next generation. In cases where all of the pigs in a litter are the same sex it is necessary to wait for another litter for a mate. In litters of 7 this will happen about once out of 64 litters. In litters of 4, however, the phenomenon will occur about once in 8 times or approximately eight times as frequently as in litters of 7. In case there is a shift in the sex ratio from equality the chances of obtaining all one sex in the same litter increase at a more rapid rate. A decrease in litter size and an increased proportion of boar pigs have made the selection of breeding stock in the present experiment rather difficult. As an illustration of this difficulty may be cited the fact that with the prevailing size of litter and proportion of males one would expect approximately one litter out of 38 in the first generation and one out of 7 in the second generation would have pigs of one sex only. The observed condition in this respect was one litter out of ten in the first and one out of four in the second generation.

Sex Ratio Abnormal

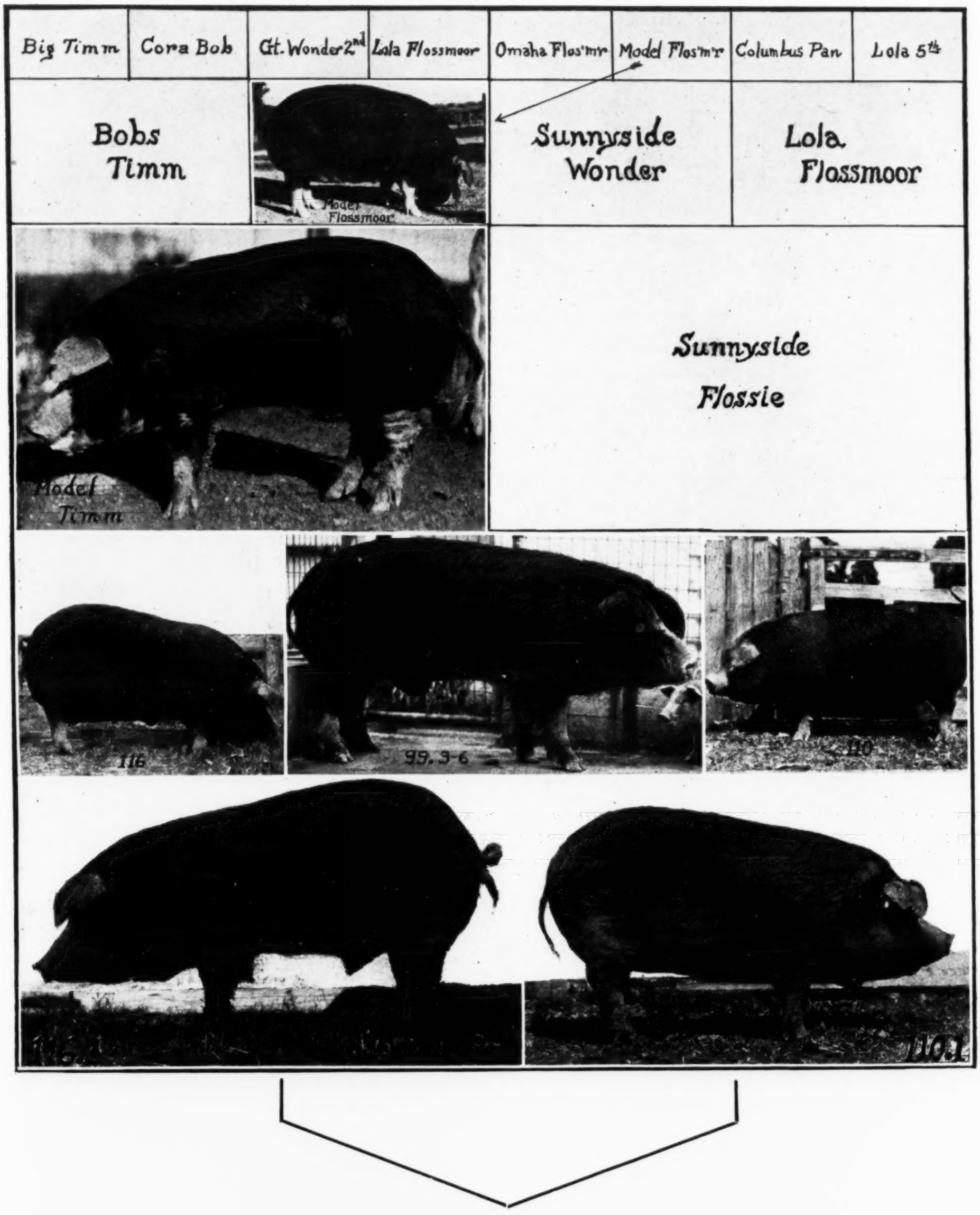
A high proportion of boar pigs has been a serious obstacle in the Poland China inbreeding experiment. In the spring of 1923 there were 28 male and 8 female pigs farrowed. In the following seasons the distribution of the sexes were more evenly balanced but nevertheless there was a high proportion of males. The 189 first generation pigs consisted of 111 males and 88 females which is 58.73 ± 2.41 per cent males. The 64 second generation inbreds consisted of 39 males and 25 females or 60.93 ± 4.11 per cent males. The proportion of males among the noninbred Poland China hogs was 52.35 ± 1.31 per cent.

The proportion of males which can be considered representative for swine in general, has been rather definitely settled by the various authors who have written upon the subject. Severson[14] found 52.30 ± 0.56 per cent males in a population of 3779 pigs composed of five pure breeds. Carmichael and Rice[1] reported 51.96 per cent in a population of 5595. In both these cases all the pigs were experimental stock upon which careful records were taken and the data may be considered reliable.* By combining these data with the data on 13,328 pigs farrowed at the field stations of the United States Department of Agriculture, a total of 22,702 is obtained. This total, which includes mostly purebred swine, contained 11,883 males and 10,819 females. The proportion of males is 52.34 ± 0.22 per cent. It is believed that this is the most representative figure thus far obtained for proportion of males in swine.

The proportion of boars among the combined first and second generation inbreds was 59.29 ± 2.04. The difference between this and the proportion of males among the noninbred Beltsville Poland China stock is 6.94 ± 2.42 which is just on the border line of significance. If the comparison is made with the figure 52.34 ± 0.22 the difference is slightly greater than three times its probable error and might, therefore, be considered significant.

Observations on the sex ratio in the inbred groups of other breeds of swine raised at Beltsville have failed to reveal a verification of the result obtained with the Poland China breed. A slight increase in percentage of boars was frequently found but nothing as extreme as occurred among the Poland China was observed. This fact leads the writers to assume that the result is a peculiarity of this single inbred line. The logical explanation is a differential prenatal mortality which favored

*It has been shown by Parkes[12] that the proportion of males is lower than expectation in herd-book data of the Duroc-Jersey breed. Later McPhee[10] showed that a similar condition existed in the Chester White breed and suggested errors of observation and recording as the probable explanation of the condition.

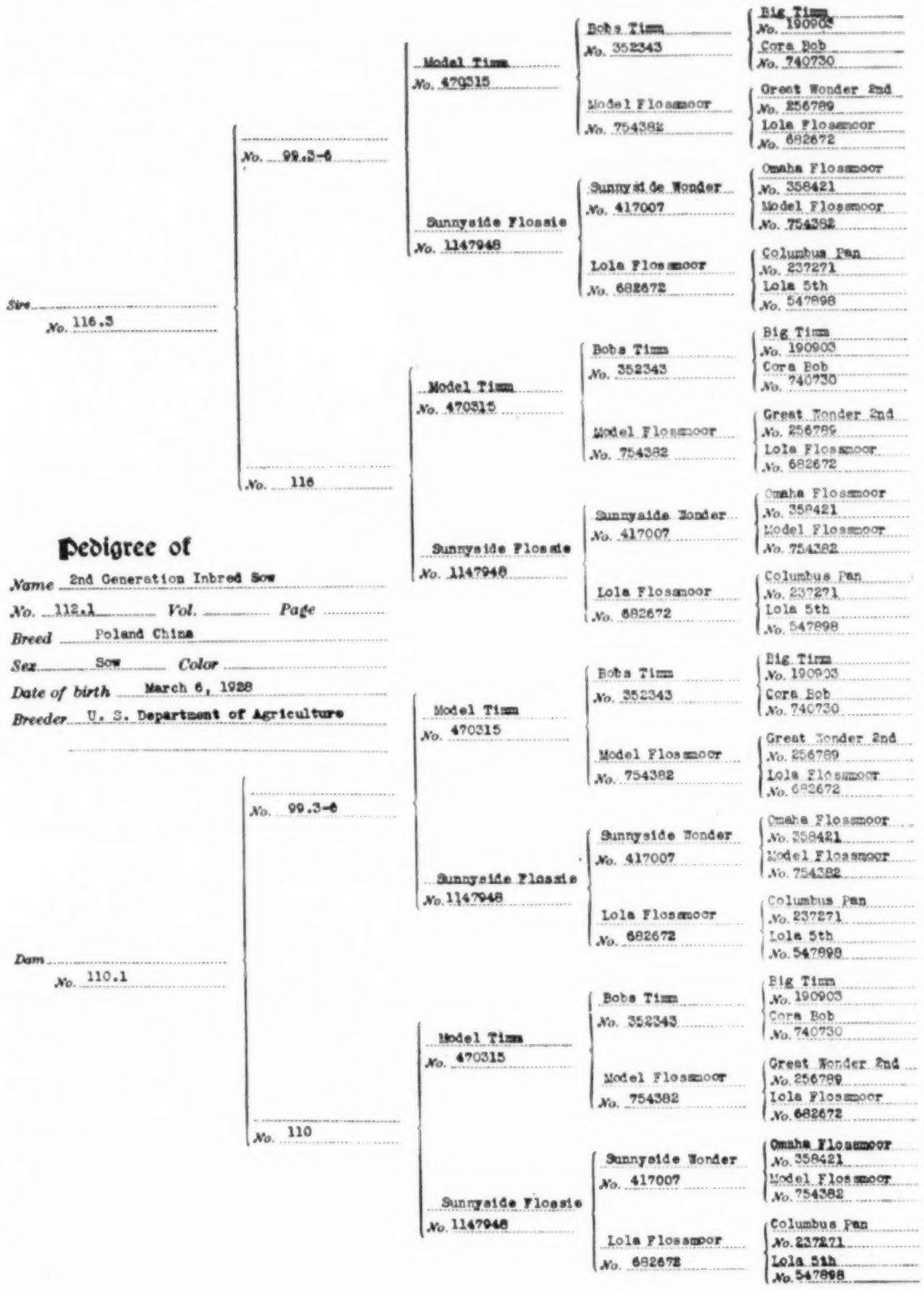


112.1

A PHOTOGRAPHIC INHERITANCE CHART OF SWINE INBREEDING

Figure 6

The full pedigree on which this chart is based is given in Figure 7. The total number of ancestors if no inbreeding were practiced is shown in the figures at the right. Thus the sow 112.1, instead of having eight great-grandparents actually has only two.



PEDIGREE OF SECOND GENERATION INBRED

Figure 7

Complete five-generation pedigree of the sow 112.1. The sixty-two possible ancestors on this family tree are actually represented by the eighteen individuals shown in Figure 6. Sows 110 and 116 were 12.5% inbred and sow 112.1 was 41.8% inbred.

NOTE.—*Sunnyside Flossie No.* 1147948 *should be Sunnyside Flossie* 2nd, *No* 1147948. *Error noted too late to change.*

the males. Of course, there is no evidence concerning the primary sex ratio in this group but there is some support for a possible differential mortality to be found in the small litter size, low birth weight, lowered vigor and high percentage of stillborn pigs in the second generation of inbreeding.

Mortality

Both the first and second generation inbreds were inferior to the control stock in percentage of young raised to weaning (70 days of age). The comparison between the lots in this respect was 41.2 per cent, 26.6 per cent and 58.1 per cent respectively. The figure for the control stock is low when considered from the standpoint of efficient hog production but this is at least partly due to the fact that the pigs are kept and handled under experimental conditions. This has involved frequent moving about of the pigs with consequent increase in liability to accidents and infection with parasites.

The causes of mortality were many and it was often difficult to determine definitely the cause of death. Of course, in many cases death had no connection whatsoever with the degree of inbreeding of the individual. Since the parent stock was itself somewhat inbred the effect of inbreeding on mortality in the first generation might be due partly to decreased vigor and milk production of the sows. It is not possible to divide accurately the total mortality into that which was due largely to the effects of inbreeding and that which was clearly due to other causes. Undoubtedly a larger proportion of the mortality in the second than in the first generation could be traced to the effects of inbreeding.

Among the first generation pigs, 11

were stillborn, 44 died of general weakness, 40 were mashed by the sow, 10 died of pneumonia, 25 of a complication of ailments, 44 were slaughtered and the remaining 15 died from a variety of specific causes including cholera, accidents and ruptures.

Among the 64 second generation pigs, 6 were stillborn, 17 died of weakness, 12 were mashed, 16 were slaughtered, and 13 died from variety of causes. Of the last number 3 had cleft plates and were unable to suckle. The group which were slaughtered included only those which were raised to 200 pounds or more. It does include a few of the heavier and more mature animals which were slaughtered when the experiment was discontinued. The same applies to the first-generation inbred group.

Pathological conditions are of the utmost importance in an experiment of this kind since an outbreak of disease can easily exterminate a stock which has any tendency toward constitutional weakness. An endeavor was made throughout the experiment to keep the pigs in good health although they were not given any special treatment different from that given the general herd. All stock was immunized against hog cholera and all young pigs were periodically treated for roundworms. They did become infested with worms, however, and possibly some of the deaths and a part of the decreases shown in gains can be attributed to the effects of such infestation. In pigs which are somewhat lacking in vigor it may be safely assumed that a worm infestation would have more marked effects than the same amount of infestation would have in a normally vigorous pig. As the number of generations of inbreeding increase this factor becomes of increasing importance as new weaknesses are brought to light. In the present experiment it cannot be said, however, that the prevalence of parasites and disease was a decisive factor in terminating the experiment because 70 per cent of the second generation pigs died of weakness and mashing at an early age, before parasites had any chance to produce much effect. The need of keeping the pigs away from worms in an experiment of this kind is not lessened by this fact, however.

Tendency to Sterility

In the production of both the first and second generation pigs, it was frequently necessary to rebreed the sows one or more times. The 9 sows used for producing first-generation pigs (Table II) were bred a total of 49 times to produce 28 litters containing 189 pigs. In the next generation 31 services produced 15 litters containing 64 pigs by 6 sows.

There was considerable variation among the sows relative to the number of services required. For instance, sow 110 farrowed 8 litters from 10 services while her sister, No. 116, farrowed only 5 litters from 12 services. The same boar was used in all services. Among the first generation sows, No. 114 has the very poor record of three second generation litters, totaling 5 pigs from 9 services.

In view of the fact that the stock was not tested for abortion diseases, it is hardly safe to conclude that the difficulty in getting sows settled was due entirely to the effects of inbreeding.

Recessive Factors Appear

Several characteristics which have appeared among the Poland China inbreds suggest the segregation of recessive genes. These include color, cleft palate, hernia and the ridgeling characteristic (testicles undescended). Due to the fact that the line of breeding could not be maintained beyond the second generation the amount of data available is entirely inadequate to warrant much discussion except in the case of color.

The sepia color which was reported on in an earlier paper[11] has proved to be an interesting color variation. At the time of the earlier report there had been farrowed by the two sows which were known to carry the gene or genes for the sepia color a total of 35 pigs

of which 4 were sepia colored. Subsequently, these two sows farrowed more sepia colored pigs, making the final proportion 74 black to 16 sepia. The expected numbers on the single factor basis are 67.5 to 22.5. The deviation is one which can probably be attributed to chance since the standard error is 16.9 while the observed deviation is only 6.5.

The appearance of the sepia pigs is due to a mixture of white, black, and banded bristles. Of course, in the white spots all the bristles are white. The black bristles are not quite as intense as in a black hog. The banded bristles are irregular as regards the position and width of the band and peculiar in that the base and tip tend to be white. Many of the bristles have two bands of black, one at the base followed by a white area then another black band surmounted by a white tip. Perhaps the typical case is a pigmented band located just back of the white tip of the bristle. The pigment is in the cortex and is indistinguishable in appearance from that of the unbanded pigmented bristles occurring in the same area and which are dilute black in color. Thus the sepia color of the hogs is due to a partial dilution of the black pigment and a mixture of white, pigmented and banded bristles.

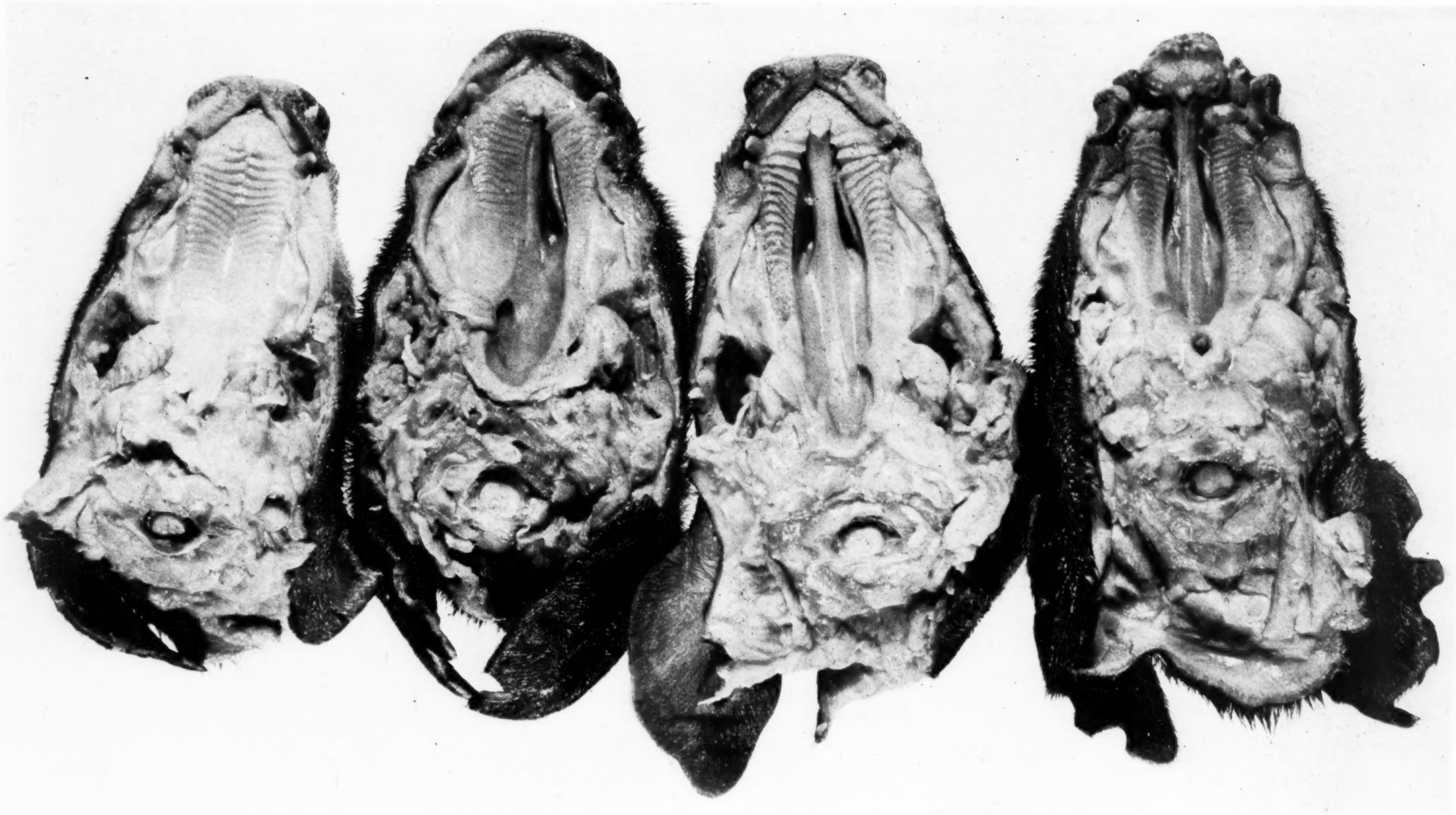
Perhaps the thing which is most interesting about the sepia color is the fact that the type of banding on the banded bristles is different from that usually found in mammals. The type which exists among many of our wild animals and which is commonly spoken of as agouti, consists of a dark colored base and tip with a band of lighter color in between. Such a banding is found among wild swine, particularly in those of China (*Sus moupinensis*). This species shows a typical banded bristle which is frayed at the tip. There is some diversity in the banding on different regions of the body, the long bristles on the back being black with a light brown tip and some of the bristles along the neck and jowl having almost pure white tips. There are also a few unpigmented bristles. This type of coloration is dominant in crosses.

It is evident that the banding which is present in some of the bristles of the sepia colored pig is quite different from that found in the wild hog. Not only is the arrangement of light and dark reversed in the sepia pig but the condition is evidently due to recessive factors. This type of banding is not unknown elsewhere, however, but occurs in the badger where the hairs are light tipped with a dark band adjoining and then a lighter colored base. Our knowledge of the genetics of the badger does not tell anything concerning the dominance of this condition.

It seems clear that the sepia color has resulted from a recessive mutation of a color gene which is located on the same chromosome with one or more genes for spotting. It is regretted that the failure to raise any of the sepia colored pigs to breeding age has prevented the proving of the one-factor hypothesis of the dilution and the obtaining of critical breeding data on the nature of the banding of the bristles. The birth-weights and causes of death did not indicate a lethal effect of the gene change and the sexes were equally divided in the sepia group.

Discussion

The scattered accounts of success and failure following the use of inbreeding in swine leave the reader in considerable doubt concerning the conclusions which may be drawn from the rather meager data which are presented. Many of the reports which have become widely disseminated throughout early swine literature are based only on general observations. Among these are the statements made by Rhode,[13] Coburn,[3] Dietrich,[6] Chapeaurouge[2] and Day.[5] All condemn consistent inbreeding as a general practice but point out that the end result will be good or bad, depending upon the nature of the foundation stock and the ability of the breeder to select the individual which,



NORMAL AND CLEFT PALATE IN SWINE

Figure 8

Three specimens of cleft palate appeared in a second generation litter. A normal palate from a pig from the same litter is shown on the left. Pigs so affected die in one or two days because they cannot create a sufficient vacuum in their mouths to take nourishment. For this reason cleft palate in mammals might be considered a secondary lethal character. Observations made on human beings and on dogs indicate that the defect is inherited, probably as a recessive.

when mated, will produce offspring having desirable characteristics.

More specific information is furnished by the experience of Mr. N. H. Gentry of Missouri with inbreeding among Berkshires. Available accounts convey the thought that Mr. Gentry made a practice of mating close relatives and was so consistently successful that he did not introduce any new boars into his herd for a period of over twenty years.

More recently Hays[8] has reported on an investigation of swine inbreeding which was carried on at the Delaware Agricultural Experiment Station for a period of nearly ten years. The plan followed consisted of double mating Berkshire sows to both Berkshire and Yorkshire boars. The crossbred pigs would be white in color and, of course, could be identified. It was found that the inbred pigs were less vigorous, showed higher mortality and made slower gains than the crossbreds. Analysis of the data indicated that a large complex of factors other than degree of relationship between sire and dam were affecting the characteristics being studied.

Still more recently Craft[4] has given a preliminary report on two generations of limited inbreeding of half brother-sister Duroc-Jersey swine. He found that the inbreds were more variable in body measurements, weights and rate of gain than the outbreds. Size of litter, both at farrowing and at weaning time, was greater in the inbred group.

The possibility of establishing a strain of animals which will breed true for a certain combination of desirable characteristics depends upon the number of genes concerned in this character complex and on the nature of the genes contained in the foundation stock from which the strain is developed. Obviously, if the foundation animals carry the heredity for recessive characteristics which are considered defects by the swine husbandman, a system of close breeding which will bring the genes together in homozygous combinations will result in hogs which are worthless to the breeder of purebred swine. For centuries it has been the aim of the breeder to rid his stock of defects and the advances made in breed improvement have been due to his ability to accomplish this. Whether one considers that the breeder of prize stock has eliminated the defects or has concentrated the desirable characteristics is immaterial. It is important, however, that the prize-winning individuals be pure in their heredity for what they appear to be, a condition which only too often is not true.

The present experiment has brought to light in a single strain the existence of several genes which affect characteristics undesirable to the swine breeder. The sepia color, if it could have been perpetuated, probably would have created a new breed differing from the standard Poland China only by the color. This color with its large amount of irregular spots is not, however, as acceptable as the solid black with white points. Cleft palate, a lethal condition, is probably dependent on one or more genes although in making this inference one must rely on information from other forms, because the present experiment did not yield critical data on this point. Likewise, the mere occurrence of a ridgeling and a scrotal rupture fails to contribute anything definite concerning the heredity involved but fortunately there is other information available on these points. Warwick[15] has shown that scrotal hernia in swine is an inherited condition dependent upon two or more genes. On the ridgeling character the authors have unpublished data which strongly indicate that it is inherited although the data obtained to date are insufficient to show how many genes are involved. Other genes, particularly those which may affect fertility, rate of gain, resistance to disease and, indirectly, sex ratio, are so intimately tied up with nutrition and environment that the study of them is confronted with many difficulties and the results of the experiment cannot be interpreted in this respect. It is apparent from the results, however, that

heredity for the expression of superiority in the various elements which make up vigor was not being fixed in the present experiment. On the other hand the evidence is rather indicative of a concentration of weaknesses in the various elements of general vigor. Size of litter dropped from 7.15 in the controls to 4.25 in the second generation of inbreeding. Per cent born dead increased from 3.03 to 9.37 and per cent raised to weaning age (70 days) decreased from 58.1 to 26.6. This result is a strain characteristic and not a breed one. It seems probable that the result was influenced to a large extent by the concentration of the heredity of Bobs Timm 352343 and Model Flossmoor 754382.

The reaction of the breeder of purebred swine toward such experiments may not be in all cases an entirely favorable one due to the fact that the end result as measured in terms of market hogs, was rather disastrous. A careful consideration of the situation, both from the viewpoint of the geneticist and that of the breeder, however, may show that the situation is not as bad as it first appeared to be. The breeder is naturally interested in having all of his pigs show excellent characteristics because it means more profit for him. Frequently he crosses with another strain to cover up deficencies in his own. He may eliminate certain pigs of a litter by sending them to the butcher because they show some characteristic which makes them less valuable as breeding stock. The remainder of the litter and possibly the parents themselves, however, may be sold as pure breeders. Thus the hidden defects may be widely disseminated. The geneticist is interested in having the various characteristics brought to light and fixed so that he may experiment with them and establish a method of their elimination from or retention in the herds where they appear. If a large percentage of defectives appear during such an experiment as the present one, it is not a matter of great consequence from the production standpoint because the geneticist is not a hog producer except in the sense that he hopes by means of the knowledge gained in his work to aid the breeder by advising how this or that condition can be corrected. At the present time the field of genetics, as applied to swine, has hardly been scratched and there is an opportunity for the experimentalist to render valuable service by cultivating a closer acquaintance with the multiplicity of material involved and trying to find out the hereditary mechanism for many characters which breeders have for years been dealing with on a chance basis. It is particularly important that information be obtained concerning the rôle of inheritance in the development of characteristics which are important from the production standpoint.

Summary

1. In the swine breeding work at the U. S. Animal Husbandry Experiment Farm, Beltsville, Md., an attempt to establish an inbred strain of Poland China swine by brother-sister mating failed in the second generation, due to a decrease in fertility and high mortality.

2. In the first generation of inbreeding litter size did not significantly decrease but average birth weight and per cent of pigs raised to 70 days of age were less than in the control stock.

3. In the second generation litter size became very much reduced and the vigor of the pigs greatly decreased. Very few second-generation inbreds were raised.

4. There was a slightly higher percentage of stillborn pigs among the inbreds than among the controls.

5. The percentage of males was greater among the inbreds than among the controls. Differential prenatal mortality is suggested as an explanation of this condition.

6. The segregation of several recessive genes is indicated by the results. One of these brings about a dilution of the black to a sepia and is apparently linked with white spotting.

A peculiar kind of banding of the bristles is associated with the dilution factor but its genetic nature could not be determined. Other characters which are known to be inherited but the exact details of which are lacking, appeared among the inbreds. These include cleft palate, scrotal hernia, and the ridgeling character.

7. There is no basis for assuming that the results of this experiment are typical of the Poland China breed. Other strains of breeding might show a very different result with the same amount of inbreeding.

Literature Cited

1. Carmichael, W. J. and J. B. Rice. 1920. Variations in farrow: with special reference to the birth weight of pigs. *Ill. Agr. Exp. Sta. Bull.* 226, p. 67-95.
2. Chapeaurouge, A. de. 1909. Einiges über Inzucht u. ihre Leistung auf verschiedenen Zuchtgebieten. Hamburg.
3. Coburn, F. D. 1909. Swine in America. New York.
4. Craft, W. A. Summary of results on limited inbreeding and outbreeding with Duroc Jersey swine. Mimeographed report from Animal Husbandry Dept., Okla Agr. Expt. Sta.
5. Day, G. E. 1913. Productive Swine Husbandry. Philadelphia.
6. Dietrich, Wm. 1912. Swine Breeding, Feeding and Management .Chicago.
7. Gentry, N. H. 1905. *Amer. Breeders' Asso.* 1:170-171.
8. Hays, Frank A. 1919. Inbreeding animals. *Delaware Agricultural Expt. Sta. Bull.* 123.
9. Lush, Jay L., J. M. Jones and W. H. Dameron. 1930. The inheritance of cryptorchidism in goats. *Texas Agr. Expt. Bull.* 407.
10. McPhee, Hugh C. 1927. The Swine herdbook as a source of data for the investigation of the sex ratio and frequency of sex combinations in pig litters. *Jour. Agr. Res.* 34, No. 8:715-726.
11. McPhee, Hugh C. and John H. Zeller. 1925. Unusual Coat Colors in swine. *Journal of Heredity* XVI. No. 9, 347-350.
12. Parkes, A. S. 1923. Studies on the sex ratio and related phenomena. (4) The frequencies of sex combinations in pig litters. *Biometrika* 15:373-381.
13. Rohde, Ottmar. 1892. Schweine-Zucht.
14. Severson, Albert. 1925. Prolificacy of sows and mortality of pigs. *Proc. Amer. Soc. An. Prod.* 60-62.
15. Warwick, B. L. 1926. A Study of Hernia in Swine. *Wisc. Agr. Expt. Sta. Res. Bull.* 69.

Table I. Weights, sex ratio, size of litter and per cent raised to 70 days of age among the inbred and non-inbred Poland China swine farrowed during the period, Spring, 1924-Spring, 1928, inclusive.

Pigs	Generation	Birth Weight	70-day Weight	Sex ratio*	Size litter	Per cent born dead	Per cent raised to 70 days
Number		Pounds	Pounds				
694	General herd	2.75±0.02	34.7±0.32	109.7	7.15±0.19	3.03	58.1
189	First	2.31±0.03	33.8±0.08	126.1	6.75±0.34	6.35	41.2
64	Second	2.29±0.04	28.9±1.00	156.0	4.26±0.48	9.37	26.6

*Number of males per 100 females.

Table II. Relation between number of litters and pigs produced and the number of times the sows were bred for the production of first and second generation inbred pigs.

First Generation						Second Generation					
Sow No.	Times bred	No. litters	Boars	Sows	Total	Sow No.	Times bred	No. litters	Boars	Sows	Total
108	6	5		16	30	112	3	3	8	5	13
110	10	8	31	32	63	113	7	4	11	7	18
111	7	5	23	13	36	114	9	3	4	1	5
113	4	3	12	4	16	115	3	2	6	5	11
114	3	0	0	0	0	117	5	1	1	0	1
115	2	1	6	1	7	119	4	2	9	7	16
116	12	5	17	10	27						
117	2	1	8	2	10						
118	3	0	0	0	0						
Total	49	28	111	78	189		31	15	39	25	64

THORNLESS AND PRODUCTIVE

Figure 9

A fruit cluster of the productive thornless sport of the Evergreen blackberry (*Rubus laciniatus*). The berries are of normal size for the variety.

A PRODUCTIVE THORNLESS SPORT OF THE EVERGREEN BLACKBERRY

GEO. M. DARROW*

THORNY ON ONE SIDE

Figure 10

Sectorial chimera of the Evergreen blackberry. This section of cane was thorny on one side and thornless on the other and leaves were thorny or thornless according to their position on the cane.

WHILE studying the variations in the Evergreen blackberries in Oregon in 1930 the writer was especially interested in looking for thornless sports. Thornless sports of the Evergreen previously seen or reported have been entirely or nearly sterile and very weak. A thornless sport now growing at the Oregon State Experiment Station is entirely sterile and a dwarf.

When visiting the fields of Mr. Philip Steffes, in the Willamette Valley, the first productive thornless sport was seen that has come to the writer's attention. Mr. Steffes obtained tip layers about 1926 from a thornless plant which was growing in the wild near some bushes of the common thorny type, and which was apparently a sport of the thorny type. From propagations of this bush Mr. Steffes has several acres of this thornless sport and a number of plants in full bearing. The planting in full bearing produced typical Evergreen blackberry fruit. (Figure 9.) The plants were apparently as vigorous and hardy as those of the thorny Evergreen and as desirable in every way.

It was of interest to determine

*Senior Pomologist, Bureau of Plant Industry, United States Department of Agriculture.

whether or not this sport was a varietal chimera—that is, whether the thornless tissue was a thin layer overlying thorny tissue, whether the plants were made up entirely of thornless tissue. If a sport is of chimeral nature, plants grown from root cuttings should resemble the original variety as the bud which forms the new shoot comes from inner tissue in the case of root cuttings. Therefore, if this is a chimera, it should produce thorny shoots from root cuttings just as happens with the Cory Thornless[1] and the Thornless Young.[2] Shoots from their roots are always thorny. The Austin Thornless and the Santa Rosa and Sebastopol Thornless blackberries of Burbank on the other hand are not chimeral, and come thornless from root cuttings.

A search of Mr. Steffes' field revealed occasional thorny canes coming from roots of the Thornless Evergreen. Furthermore, two canes were found which were thorny on one side and thornless on the other. Occasional leaf petioles (Figure 10) and fruit pedicels were also observed showing thorns. Apparently the Thornless Evergreen is chimeral in character, with a thin layer of thornless tissue overlying the tissue of the usual thorny type. It will, therefore, have to be propagated by layering the tips, just as in the case of the Cory and Thornless Young. Several hundred seedlings of this Thornless Evergreen were all thorny.

Since visiting Mr. Steffes' place, a Mr. Butterfield of Woodburn, Oregon, has reported having at one time found a thornless cane which had fruited in his fields. No young thornless canes for propagation, however, were found.

Literature Cited

1. Darrow, Geo M. 1928. Notes on Thornless Blackberries. *Jour. of Heredity,* 19: 139-142.

2. ————. 1929. Thornless Sports of the Young Dewberry. *Jour. of Heredity,* 20: 567-569.

Author's Note: Since writing this article another thornless productive sport of the Evergreen has been reported from western Washington. Many new thornless sports of the young dewberry also have been seen, some productive and some sterile. One sterile thornless sport of the Logan has also been seen. There seems to be some evidence that genetically the thornless sport tissue of all these berries is sterile and that only when the thornless tissue is very thin and when the flowers and fruit are formed from the original thorny tissue are thornless sports productive. July 31, 1931.—*Geo. M. Darrow.*

MEMBERSHIP BLANK

The American Genetic Association,
Victor Building,
Washington, D. C.

Gentlemen: I ☐ enclose ☐ will remit $3.00 for membership for one year. This entitles me to receive the Journal of Heredity each month and all other privileges of membership without any further obligation on my part.

Name.....

Street and Number.....

City and State.....

Nominated by.....

Member A. G. A.

Index to Volume XXII

OF THE

Journal of Heredity—1931

A

Acoustic Tumors, Hereditary, 7.
Aftereffect Produced by X-rays, 221.
Aleurone Color, Dilute in Maize, 225.
Alee, W. C., Cooperation in Evolution (excerpt), 225.

Animal Genetics and Animal Breeding:

Body Weight Genetics in Fowl, 283.
Breeding the Best Shorthorns, 245.
Color Chimeras in Fowl, 133.
"Dominant Spotting" in the Mouse, 273.
Four-ounce Eggs from Manchuria, 77.
Genes of Platyfish, 169, 185.
Genovariations, reverse, 67.
Hairlessness in Swine, 125.
Hen with Variable Plumage Color, 59.
Hernia Inherited in Cattle, 345.
Heterosis in Guinea Pigs, 187.
Inbreeding, Swine, 393.
Inheritance in Poultry, 147.
Laboratory Mouse (Rev.), 186.
Linkage in Sheep, 9.
Livestock Breeding in Russia, 188.
Melanin and Cancer, 244.
Melanism in Moths, 323.
Mutation in a Borborid Fly, 35.
Naked Sheep, 91.
Poultry Congress, 120.
Poultry Husbandry (Rev.), 23.
Sextuplet Lambs, 229.
Two-headed Turtle, 137.
X-ray, Genetic Aftereffect of, 221.
Zebu-Yak Hybrids, 297.

Annas Sativus Lindl., Cytology, 139.
Anthropology and Eugenics (Rev.), Paul Popenoe, 277.
Asiatic and American Centers of Domestication (Rev.), 387.
Atheroma, Inheritance of, 3.
Atkeson, F. W., and T. R. Warren, Inheritance of Hernia, 345.

B

Banker, Howard J., Distribution of School Success in Families, 373.
Barley, Origin of Hooded, 265.
Bartlett Pear, Bud Variation in, 81.
Beans, Nematode Resistance in, 191.
Beans, New Pod Color in, 21.
Biological Prospectus (Rev.), J. H. Kempton, 280.
Birthrates, Urban and Rural, 58.
Blackberry Seedlings and Hybrids, 143.
Blackberry, Thornless, 405.
Body Weight in Fowl, 283.
Bone-Fragility Inherited, 105.

Books Reviewed and Books Received:

The Adventure of Mankind, Eugene George, 282.
Allgemeine Rassenkunde, Walter Scheidt, 280.
America's Sex, Marriage and Divorce Problems, William J. Robinson, 380.
Animal Aggregations, W. C. Allee, 357.
Asiatic and American Centers of Domestication (Rev.), N. I. Vavilov, 388.
Biology and Mankind, S. A. McDowell, 357.
Biology in Human Affairs, E. M. East, Editor, 185, 280.
Birth Registration and Birth Statistics in Canada, R. R. Kuczynski (Rev.), 89.
By Word of Mouth, T. W. Bolydyreff, 282.
Can Science Explain Life? Carl F. Krafft, 228.
Collected Papers on Eugenic Sterilization in California, E. S. Gosney and Paul Popenoe, 187.
Communicable Disease Control, Report of Committee of White House Conference, 379.
Cosmic Consciousness, Richard Maurice Bucke, 282.
The Development of Character Traits in Young Children, Amelia McLester, 187.
Die Biologie Der Person (Rev.), 49.
Discovering Ourselves, E. A. Strecker and K. E. Appel, 187.
Diseases Transmitted from Animals to Man, Thomas G. Hull, 58.
Drifting Sands of Party Politics, Oscar W. Underwood, 57.
Education, Crime, and Social Progress, William C. Bagley, 228.
Enlargement of The Personality (Rev.), 19.
The Exchange of Energy Between Man and the Environment, L. H. Newburgh and Margaret Woodwell Johnston, 154.
Exploring for Plants (Rev.), David Fairchild, 324.
The Fallacies of Fatalism (Rev.), Chas. E. Hooper, 226.
Fungus Diseases of Plants, Jacob Eriksson, 50.
Genetic Studies of Genius, III—The Promise of Youth, Burke, Jensen and Terman, 57.
The Genetics of Domestic Rabbits, W. E. Castle, 391.

Books Reviewed (Continued)

The Guidance of Mental Growth in Infant and Child, Arnold Gesell (Rev.), 161.
Health on the Farm and In the Village, C. E. A. Winslow, 379.
L'Heredite, E. Guyenot, 186.
Heredity, A. Franklin Shull, 228.
Heredity in Man, (Rev.), R. Ruggles Gates, 75.
The Horse of the Desert, William Robinson Brown, 282.
Human Heredity, E. Baur, E. Fischer, F. Lenz, 227, 355.
An Hypothesis of Population Growth, Ezra Bowen, 321, 282.
Infancy and Human Growth, Arnold Gesell, 64.
International Directory of Pedigree Stock Breeders, R. de Toll, 56.
International Migrations, Walter F. Willcox, Editor, 357.
Kunstliche Gesechlechtsumwandlungs-Kreuzungs und Befruchtungs-Versuche Bei Fischen. Herbert Schmidt, 185.
The Laboratory Mouse, Clyde E. Keller, 186.
Like Breeds Like, Harry H. Cook, 228.
Maize in South Africa, A. R. Saunders, 228, 356.
The Making of Man, V. F. Calverton, 228.
Manual on Research and Reports, 56.
Mendelism and Evolution, E. B. Ford, 357.
Mendel's Principles of Heredity, W. Bateson, 76.
The Mental Defective, Richard J. A. Berry and R. G. Gordon, 357.
Mental Measurement of Pre-school Children, Rachel Stutsman, 343.
Mexico, Stuart Chase, 282.
The Money Illusion, Irving Fisher, 56.
Morphologie und Physiologie des Formwechsels der Moose auf genetischer Grundlage II, F. Von Wettstein (Rev.), 80.
The Mothers, Robert Briffault, 185.
The Mysterious Universe, Sir James Jeans, 57.
The New Road to Civilization, H. G. Baker, 357.
A New Theory of Heredity, George Arthur Gaskell, 186.
Nut Growing, Robert T. Morris, 228.
L'Oeuf et Les Facteurs de L'Ontogenese, A. Brachet, 186.
Order of Birth, Parent-age, and Intelligence, L. L. Thurstone and Richard L. Jenkins, 228.
La Parthenogenese, A. Vandel, 186.
The Physical Basis of Personality, Charles R. Stockard, 186.
Physique and Intellect, Donald G. Paterson (Rev.), 216.

Books Reviewed (Continued)

Plant Physiology, Edwin C. Miller, 227.
Poultry Husbandry, M. A. Jull, 23.
Preparation of Scientific and Technical Papers, Sam F. Trelease and Emma Sarepta Yule, 185.
Le Probleme de L'Evolution, Maurice Caullery, 282.
The Problems of Evolution, Arthur Ward Lindsey, 185.
Puritan's Progress, Arthur Train, 57.
Race Mixture, Edward Byron Reuter, 185.
Rassenkunde des deuteschen Volkes, Hans F. K. Gunther, 280.
The Regulation of Size as Illustrated in Unicellular Organisms, Edward F. Adolph, 57.
The Science of Biology, George G. Scott, 57.
Selbststerilitat und Kreusungesterilitat, Friedrich Brieger, 70.
Sex Hygiene and Reproduction of Cattle, W. W. Williams, 186.
Some More Medical Views on Birth Control, Norman Haire, 186.
Some Recent Researches in The Theory of Statistics and Actuarial Science, J. F. Steffensen, 228.
Studien Zur Fertilitat, G. L. Moench, 228.
The Technique of Social Progress, Hornell Hart, 324.
Textbook of Experimental Cytology, James Gray, 228.
A Thousand Marriages, Robert Latou Dickinson and Laura Beam, 357.
Up From the Ape, Earnest Albert Hooton (Rev.), 352.
Ursprung und Verbreitung des Menschengeschlechts, Franz Kock, 280.
Weeds in the Garden of Marriage, George Pitt-Rivers, 357.
What is Life? Augusta Gaskell, 228.
White House Conference, Report of, 379.
Zur losung des Problems der Blutgruppenvererbung, K. H. Bauer, 280.
Brachydactyly in Feet of Humans, 163.
Brahama-Yak Hybrids, 297.
Breeding in Russia, 188.
Breeding the Best Shorthorns, 245.
Brevis Maize, H. W. Li, 14.
Brink, R. A., and P. H. Senn, Ragged, A Dominant Character in Maize, 155.
Brockelbank, E. E., and L. M. Winters, Study of the Methods of Breeding the Best Shorthorns, 245.
Broken-Boned People, 105.
Bromelia pinguin, L. Cytology, 139.
Budd, Joseph Lancaster, 66.
Bud Variation in Bartlett Pear Trees, A. D. Shamel, C. S. Pomeroy and F. N. Harmon, 81.

C

Canadian Vital Statistics (Rev.), Joseph J. Spengler, 89.
Cancer, and Melanin, 244.
Can Single-Ovum Twins be of Opposite Sexes? Max Levin, 17.
Carroll, W. E., and Elmer Roberts, Inheritance of Hairlessness in Swine, 125.
Cattle, Breeding Shorthorn, 245.
Cattle, Inheritance of Hernia in, 345.
Cederstrom, J. A., a Two-headed Turtle, 137.
Children's Charter, 353.
Chimeras in Fowl, 133.
A Chimera in the Poinsettia, T. Ralph Robinson, 359.
Chromosome Number in Pineapple, 139.
Chromosome Number in Plants, 244.
Collins, J. L., and Kenneth R. Kerns, Genetic Studies of the Pineapple, 139.
Color Change in Fowl, 59.
Color Chimeras in the Domestic Fowl, C. W. Knox, 133.
Color Pattern Variations in Fish, 169, 185.
Compendium of Human Heredity (Rev.), Robert Cook, 75.
Conjoined Twins, 201.
Cook, O. F., Inequality of Cotton Fibers 25.
Cook, Robert C., Asiatic and American Centers of Domestication (Rev.), 387; Chromosome Number in Plants, 244; Compendium of Human Heredity (Rev.), 75; First Plant Patent, 262, 313; Genes of the Morning Glory, 244; Inheritance of Induced Melanism in Moths, 323; James Wilson (1835-1920), 5; John Ray, 98; Joseph Lancaster Budd, 66; Melanin and Cancer, 244; Nicotine Percentage in Tobacco Breeding, 226; Nordics, Alpines and Slavs, 243; Three More Plant Patents, 369; Schizophrenia, 244; Two Eugenics Journals, 243.
Cooperation in Evolution, 366.
Correction in Kostoff's Paper 1930) 13.
Cotton Fibers, Inequality of, 25.
Cotton, Radiation-Induced Variation in, 253.
"Crooked Neck" in Poultry, 147.
Cucurbita Pepo, Size and Shape Factors in, 381.
Currence, T. M., New Pod Color in Snap Beans, 21.
Cutter Ray T., and W. M. Nelson, A Short-Toed Family, 163.
Cytology of Pineapple, 139.

D

Darrow, George M., European Blackberry Seedlings and Hybrids, 143; Productive Thornless Sport of the Evergreen Blackberry, 405.
Deafness inherited, 7.
Dementia Praecox, 244.
Depopulation of England, 73.
Dermatoglyphics in Twin Diagnosis, 41.
Dicephaly in Turtle, 137.
Dickerson, L. M., Inheritance of Ruby Seed Coat Color in Peas, 319.
Differences Between Conjoined Twins, H. H. Newman, 201.
Dilute Aleurone in Maize, 225.
Disease of Plants, C. E. Leighty (Rev.), 50.
Distribution of School Success in Families, Howard J. Banker, 373.
Does X-ray Treatment Produce a Genetic Aftereffect? N. W. Timofeeff-Ressovsky, 221.
Dominant Spotting in the Mouse, 273.
Drosophila melanogaster, Reverse Gene Mutations in, 67.

E

Education and Eugenics, Paul Popenoe, 217.
Eggs, Four-ounce, 77.
Emerson, Haven, Race Differences in Disease (Excerpt), 198.
Euchlaena, Maize, and Tripsacum, Hybridization of, 329.
Eugenics, See also *Human Heredity*.
Eugenics and Anthropology, 277.
Eugenics and Education, 217.
Eugenics, Not "Bluegenics" (Excerpt), 16.
Eugenics, Social Factors Influencing, 102.
European Blackberry Seedlings and Hybrids, George M. Darrow, 143.
Experiment with Inbreeding Swine, 393.
Exploring for Plants (Rev.), Wilson Popenoe, 324.
Eye-defect in Twins, 17.
Eyster, William H., Heritable Characters of Maize: Dilute Aleurone, 225; Male Sterile, 99, 117; Reduced Endosperm, 251.

F

Families, Prizes for Large, 272.
Fertility in Sheep, 229.
First Plant Patent, 262, 313.
Fish, Melanin and Cancer in, 244.
Fish, Pattern Genes in, 169, 185.
Fisher, R. A., Visits the U. S., 66.
Fly, Mutation in a Borborid, 35.
"For Every Child," The Twentieth Pledge, 353.
Four-ounce Eggs from Manchuria, Taiji Kohmura, 77.
Fowl—
  Body Weight in, 283.
  Color Chimeras in, 133.
  Four-ounce Egg Production, 77.
  Inheritance of Hen Feathering, Vulture Hock, Crooked Neck in, 345.
  Poultry Husbandry (Rev.), 23.
  Variable Plumage Color, 59.
  World's Poultry Congress, 120.
Fragile-Boned Family, D. Y. Holcomb, 105.
Fraser, Allan C., and Myron Gordon, Pattern Genes in the Platyfish, 169.

Frazier, Charles H., and W. James Gardner, Hereditary Bilateral Acoustic Tumors, 7.
"Free Will" and Determinism, N. D. C. Lewis (Rev.), 226.
From Ape to Man (Rev.), R. B. Kelley, 352.
Fukuoko, Goro, and Taku Komai, A Set of Dichorionic Identical Triplets, 233.

G

Gardner, W. James, and Charles H. Frazier, Hereditary Bilateral Acoustic Tumors, 7.
Genes of the Morning Glory, 244.
Genetic Studies of the Pineapple, J. L. Collins and Kenneth R. Kerns, 139.
Genetics of Mosses, Walter Landauer (Rev.), 80.
Genovariations, Reverse, 67.
German Eugenics Text Translated (Rev.), S. J. Holmes, 355.
Gillette, C. P., An Inheritable Defect of the Human Hand, 189.
Godbey, D. B., and D. H. Reid, Hen with Variable Plumage Color, 59.
Gordon, Myron, and Allan C. Fraser, Pattern Genes in the Platyfish, 169.
Gossypium hirsutum, Changes Induced by X-raying, 253.
Gregory, D. W., and J. F. Wilson, Sextuplet Lambs, 229.
Grier, N. M., How We Grow Up (Rev.), 64; The Power Plant of Life (Rev.). 154.
Guide for Poultry Specialists (Rev.), F. B. Hutt, 23.
Guiding Mental Growth (Rev.), N. D. C. Lewis, 161.
Guinea Pigs, Heterosis in, 187.

H

Hairlessness in Swine, 125.
Hand, Heritable Defect in, 189.
Harlan, Harry V., The Origin of Hooded Barley, 265; A Reprint of "Mendel's Principles of Heredity" (Rev.), 76.
Harmon, F. N., A. D. Shamel and C. S. Pomeroy, Bud Variation in Bartlett Pear Trees, 81.
Harper, Roland M., Some New Light on the Inheritance of Longevity, 93.
Hen, See *Fowl.*
Hen with Variable Plumage Color, C. B. Godbey and D. H. Reid, 59.
Heredity, see *Animal and Plant Genetics, Human Heredity.*
Hereditary Bilateral Acoustic Tumors, W. James Gardner and Charles H. Frazier, 7.
Hereditary Again Recognized by Law, Joseph Rossman, 63.
Heredity and the White House Conference, 92.
Heritable Characters in Maize:
Brevis, H. W., Li, 14.
Dilute Aleurone, William H. Eyster, 225.
Ragged, R. A. Brink and P. H. Senn, 155.
Male Sterile$_2$, Male Sterile$_3$, William H. Eyster, 99, 117.
Reduced Endosperm, William H. Eyster, 251.
Hernia, Inheritance of, 345.
Heterosis in Guinea Pigs, 187.
Heterosis in Poultry, 120.
Holcomb, D. Y., A Fragile Boned Family, 105.
Holmes, S. J., A German Eugenics Text Translated (Rev.), 355; Is England Approaching Depopulation? 73; Revised Edition of Walter's "Genetics" (Rev.), 389.
Hordeum aegiceras (Hooded Barley), Origin of, 265.
Horlacher, W. R., and D. T. Killough, Radiation-Induced Variation in Cotton, 253.
How We Grow Up (Rev.), N. M. Grier, 64.
Human Constitution, The (Rev.), Walter Landauer, 49.
Human Heredity and Eugenics:
Anthropology and Eugenics, 277.
Biology in Human Affairs (Rev.), 280.
Birthrates, Urban and Rural, 58.
Body and Mind (Rev.), 216.
Bone-fragility Inherited, 105.
Canadian Vital Statistics (Rev.), 89.
Eugenic Sterilization, 187.
Cooperation in Evolution (Excerpt), 366.
Dementia Praecox, 244.
Differences Between Conjoined Twins, 201.
Education and Eugenics, 217.
Enlargement of Personality (Rev.), 19.
Eugenics Journals, 243.
Eugenics, Not "Bluegenics" (Excerpt), 16.
From Ape to Man (Rev.), 352.
Genetics of Genius (Rev.), 57.
Guiding Mental Growth (Rev.), 161.
Heredity and Psychology, 358.
Heredity in Man (Rev.), 75.
Human Constitution (Rev.), 49.
Human Heredity (Rev.), 227.
Hypothesis of Population Growth (Rev.), 282.
Identical Triplets, 233.
Identical Twins of Opposite Sexes, 17.
Inheritable Defect of the Human Hand, 189.
Inheritance of Longevity, 93.
Intelligence and Heredity, 373.
Mental Tests for Infants (Rev.), 343.
Nordics, Alpines and Slavs, 243.
Order of Birth, Parent-age, and Intelligence (Rev.), 228.
Palm-prints of Twins, 41.
Population Changes in England, 73.
Population Growth (Rev.), 321.
Prizes for Large Families, 272.
Proud of Our Weeds, 344.
Psychiatrist on Sterilization, 119.

Race Differences in Disease (Excerpt), 198.
Short-Toed Family, 163.
Social Factors Influencing Eugenics, 102.
Sterilization in Nebraska, 63.
Tumors Inherited, 3, 7.
White House Conference and Heredity, 92, 353.
Hutt, F. B., Guide for Poultry Specialists (Rev.), 23.
Hybridization of Maize, Tripsacum, and Euchlaena, P. C. Mangelsdorf and R. G. Reeves, 329.
Hybrids, Blackberry, 143.
Hybrids, Maize, Tripsacum, and Euchlaena, 329.
Hypotrichosis in Swine, 125.

I

Identical Triplets, Japanese, 233.
Imai, Yoshitaka, New Mutant Characters of the Japanese Morning Glory, 361.
Inbreeding Experiment with Poland China Swine, Hugh C. McPhee, E. Z. Russel and John Zeller, 393.
Inbreeding in Poultry, 120.
Independence of Genetic Factors Governing Size and Shape, Edmund W. Sinnott, 381.
Inequality of Cotton Fibers, O. F. Cook, 25.
"Informing the Dear Public," 358.
Inheritable Defect of the Human Hand, C. P. Gillette, 189.
Inheritance, See also *Plant Genetics, Animal Genetics, Human Heredity.*
Inheritance of Body Weight in the Domestic Fowl, Morley A. Jull and Joseph P. Quinn, 283.
Inheritance of "Hairlessness" in Swine, Elmer Roberts and W. E. Carroll, 125.
Inheritance of Hernia, T. R. Warren and F. W. Atkeson, 345.
Inheritance of Induced Melanism in Moths, 323.
Inheritance of Longevity, 93.
Inheritance of Ruby Seed Coat Color in Peas, L. M. Dickerson, 319.
Inheritance of Smut Resistance and Juiciness of Stalk in Sorghum, Arthur F. Swanson and John H. Parker, 51.
Intelligence and Heredity, 373.
Isbell, C. L., Nematode Resistance Studies with Pole Snap Beans, 191.
Is England Approaching Depopulation? S. J. Holmes, 73.

J

James Wilson (1835-1920), 5.
Jull, Morley A., Poultry Breeding and Genetics at Fourth World's Poultry Congress, 120.
Jull, Morley A., and Joseph P. Quinn, Inheritance in Poultry, 147; The Inheritance of Body Weight in the Domestic Fowl, 283.

K

Keeler, Clyde E., A New Mutation to "Dominant Spotting" (*W*) in the House Mouse, 273.
Kelley, R. B., From Ape to Man (Rev.), 352.
Kempton, J. H., A Biological Prospectus (Rev.), 280; Maize in South Africa (Rev.), 356; Soviet Factory Fables, (Rev.), 390.
Kerns, Kenneth R., and J. L. Collins, Genetic Studies of the Pineapple, 139.
Killifish, Pattern Genes in, 169, 185.
Killough, D. T., and W. R. Horlacher, Radiation-Induced Variation in Cotton, 253.
Knox, C. W., Color Chimeras in the Domestic Fowl, 133.
Kohmura, Taiji, Four-Ounce Eggs from Manchuria, 77.
Komai, Taku, and Goro Fukuoka, A Set of Dichorionic Identical Triplets, 233.
Kostoff, Correction in 1930 Paper, 13.

L

Landauer, Walter, The Human Constitution (Rev.), 49; Genetics of Mosses (Rev.), 80.
Leighty, C. E., Diseases of Plants (Rev.), 50.
Leptocera fontinalis, Wing Mutation in, 35.
Levin, Max, Can Single-Ovum Twins Be of Opposite Sexes? 17.
Levit, S., On the Inheritance of Atheroma, 3.
Lewis, N. D. C., "Free Will" and Determinism (Rev.), 226; Guiding Mental Growth (Rev.), 161; Mental Tests for Infants (Rev.), 343; Revamping the Personality (Rev.), 19.
Li, H. W., Heritable Characters in Maize, 14.
Linkage Studies in Sheep, Boris Wassin, 9.
Livestock Breeding in Russia, 188.
Longevity, Inheritance of, 93.
Lyon, E. P., The White House Conference and Heredity, 92.

M

McPhee, Hugh C., E. Z. Russell and John Zeller, An Inbreeding Experiment with Poland China Swine, 393.
Maize:
Brevis, 14.
Dilute Aleurone in, 225.
In South Africa (Rev.), 356.
Male Sterile, 99, 117.
Ragged, 155.
Reduced Endosperm, 251.
Tripsacum, and Euchlaena Hybrids, 329.
Mangelsdorf, P. C., and R. G. Reeves, Hybridization of Maize, Tripsacum, and Euchlaena, 329.

Melanin and Cancer, 244.
Melanism in Moths, 323.
Mental Tests for Infants (Rev.), N. D. C. Lewis, 343.
Metacarpals, Short, Inherited, 189.
Mouse, Spotting in, 273.
Morning Glory, Genes of, 244; Mutant Characters of, 361.
Moths, Melanism in, 323.
Multi-nipples in Sheep, 9.
Mutation in a Borborid Fly, 35.
Mutation in Bartlett Pears, 81.
Mutations, Gene in *Drosophila melanogaster*, 67.

N

Naked Lamb, E. T. Popova-Wassina, 91.
Nebraska Sterilization Statute, 63.
Necklace Pattern in Sheep, 9.
Nelson, W. M., and Ray T. Cutter, A Short-Toed Family, 163.
Nematode Resistance Studies with Pole Snap Beans, C. L. Isbell, 191.
Newman, H. H., Palm-print Patterns in Twins, 41; Differences Between Conjoined Twins, 201.
New Mutant Characters of the Japanese Morning Glory, Yoshitaka Imai, 361.
New Mutation to "Dominant Spotting" (W) in the House Mouse, Clyde E. Keeler, 273.
New Pod Color in Snap Beans, T. M. Currence, 21.
Nicotine Percentage in Tobacco Breeding, 226.
Nordics, Alpines and Slavs, 243.

O

On the Heredity of Atheroma, S. Levit, 3.
Origin of Hooded Barley, Harry V. Harlan, 265.

P

Palm-Print Patterns in Twins, H. H. Newman, 41.
Parker, John H., and Arthur F. Swanson, Inheritance of Smut Resistance and Juiciness of Stalk, 51.
Patents for Plants, 262, 313, 369.
Pattern Genes in the Platyfish, Myron Gordon and Allan C. Fraser, 169.
Pear, Bud Variation in, 81.
Peas, Ruby Seed Coat Color in, 319.
Phabitis nil, genes of, 244.
Phacophagus Grunnicus, hybrids, 297.
Pig, See *Swine*.
Pitt-Rivers, George, Proud of Our Weeds (Excerpt), 344.
Pineapple, Genetic Studies of, 139.
Plant Breeding Abstracts, 187.

Plant Breeding and Plant Genetics:

Blackberry Seedlings, Hybrids, and Mutations, 143, 405.
Brevis Maize, 14.
Bud Variation in Bartlett Pear, 81.
Centers of Domestication, 388.
Chromosome Number in Plants, 244.
Cytology of Pineapple, 139.
Dilute Aleurone in Maize, 225.
First Plant Patent, 313.
Genetics of Mosses (Rev.), 80.
Hooded Barley, Origin of, 265.
Maize, Male Sterile, 99, 117.
Maize, Tripsacum, and Euchlaena Hybrids, 329.
Morning Glory, Genes of, 244.
Mutations of Morning Glory, 361.
Nematode Resistance in Snap Beans, 191.
Nicotine Percentage in Tobacco, 226.
Peas, Ruby Seed Coat Color in, 319.
Patents for Plants, 313, 369.
"Plant Breeding Abstracts," 187.
Poinsettia Chimera, 359.
Radiation-Induced Variation in Cotton, 253.
Ragged Maize, 155.
Ray, John, Botanist, 98.
Reduced Endosperm of Maize, 251.
Smut Resistance in Sorghum, 51.
Squash, Size and Shape Factors in, 381.
Substaple in Cotton, 25.
White Snap Beans, 21.

Plant Patents, 262, 313, 369.
Platypoecilus maculatus, Genetics of, 169, 185.
Pod Color in Snap Beans, 21.
Poinsettia, Chimera in, 359.
Pomeroy, C. S., A. D. Shamel and F. N. Harmon, Bud Variation in Bartlett Pear Trees, 81.
Popenoe, Paul, Anthropology and Eugenics (Rev.), 277; Education and Eugenics, 217; Self-sterility (Rev.), 70.
Popenoe, Wilson, Exploring for Plants (Rev.), 324.
Popova-Wassina, E. T., Naked Lamb, 91.
Population Changes in England, 73.
Poultry, See also *Fowl*.
Poultry Breeding and Genetics at Fourth World's Poultry Congress, Morley A. Jull, 120.
Poultry, Guide for Specialists (Rev.), 23.
Poultry, Inheritance in, 147.
Power Plant of Life, N. M. Grier, (Rev.), 154.
Prizes for Large Families, 272.
Proud of Our Weeds, 344.
Productive Thornless Sport of the Evergreen Blackberry, George M. Darrow, 405.
Psychiatrist on Sterilization, 119.

Q

Quinn, Joseph P., and Morley A. Jull, Inheritance in Poultry, 147; The Inheritance of Body Weight in the Domestic Fowl, 283.

R

Race Differences in Disease (Excerpt), Haven Emerson, 198.

Race Hygiene (Rev.), 277.
Radiation-Induced Variation in Cotton, W. R. Horlacher and D. T. Killough, 253.
Ragged, A Dominant Character in Maize, R. A. Brink and P. H. Senn, 155.
Ray, John, 98.
Reduced Endosperm in Maize, 251.
Reeves, R. G., and P. C. Mangelsdorf, Hybridization of Maize, Tripsacum, and Euchlaena, 329.
Reid, D. H., and C. B. Godbey, A Hen with Variable Plumage Color, 59.
Reprint of "Mendel's Principles of Heredity" (Rev.), H. V. Harlan, 76.
Resistance, Nematode in Beans, 191.
Revamping the Personality (Rev.), N. D. C. Lewis, 19.
Reverse Genovariations, N. W. Timofeeff-Ressovsky, 67.
Roberts, Elmer, and W. E. Carroll, Inheritance of "Hairlessness" in Swine, 125.
Robinson, T. Ralph, A Chimera in the Poinsettia, 359.
Rossman, Joseph, Body and Mind (Rev.), 216; Heredity Again Recognized by Law, 63.
Ruby Seed Coat Color in Peas, 319.
Rural Birthrates, 58.
Russell, E. Z., et al, An Inbreeding Experiment with Poland China Swine, 393.
Russia, Breeding Livestock in, 188.

S

Schizophrenia, 244.
School Success, Distribution of, 373.
Self-sterility, (Rev.), Paul Popenoe, 70.
Senn, P. H., and R. A. Brink, Ragged, A Dominant Character in Maize, 155.
Set of Dichorionic Identical Triplets, Taku Komai and Goro Fukuoko, 233.
Sex-Reversal in Twins, 17.
Sextuplet Lambs, J. F. Wilson and D. W. Gregory, 229.
Shamel, A. D., C. S. Pomeroy and F. N. Harmon, Bud Variation in Bartlett Pear Trees, 81.
Shape, Genetics of, in Squash, 381.
Sheep, Fertility in, 229.
Sheep, Linkage Studies in, 9.
Sheep, Naked, 91.
Short Fingers Inherited, 189.
Shorthorns, Breeding the Best, 245.
Short-Toed Family, Ray T. Cutter and W. M. Nelson, 163.
"Siamese" Twins, 201.
Sinnott, Edmund W., Independence of Genetic Factors Governing Size and Shape, 381.
Smut Resistance in Sorghum, 51.
Social Factors in Influencing Eugenics, 102.
Some New Light on the Inheritance of Longevity, Roland M. Harper, 93.
Sorghum, Smut Resistance in, 51.
Spengler, Joseph J., Canadian Vital Statistics (Rev.), 89; What Governs Population Growth (Rev.), 321.
Squash, Size and Shape Factors in, 381.
Sterilization (Rev.), 277.
Sterilization, Law in Nebraska, 63.
Sterilization, Psychiatrist on, 119.
Study of the Methods of Breeding the Best Shorthorns, E. E. Brockelbank and L. M. Winters, 245.
Study of Social Factors Influencing Eugenics, 102.
Substaple in Cotton, 25.
Success, School, 373.
Swanson, Arthur F., and John H. Parker, Inheritance of Smut Resistance and Juiciness of Stalk, 51.
Swine, Experiment with Inbreeding, 393.
Swine, Hairlessness in, 125.

T

Thornless Sport of Blackberry, 405.
Timofeeff-Ressovsky, N. W., Reverse Genovariations, 67; Does X-ray Treatment Produce an Genetic Aftereffect? 221.
Tobacco Breeding, Nicotine Percentage in, 226.
Toes, Short, Inherited, 183.
Triplets, Identical Japanese, 233.
Tripsacum, Euchlaena, and Maize, Hybridization of, 329.
Tumors, Inheritance of, 3, 7.
Turner, C. L., A Wing Mutation in a Borborid Fly, 35.
Turtle, Two-headed, 137.
Twinning in Turtles, 137.
Twins, Conjoined, 201.
Twins, Identical, Opposite Sexes, 17.
Twins, Identical Triplets, 233.
Twins, Palm-print Patterns in, 41.
Two Eugenics Journals, 243.
Two-Headed Turtle, J. A. Cedarstrom, 137.

U

Urban and Rural Birthrates, 58.

V

Vavilov, N. T., Asiatic and American Centers of Domestication (Rev.), 388.
Vulture Hock in Poultry, 147.

W

Warren, T. R., and F. W. Atkeson, Inheritance of Hernia, 345.
Wassin, Boris, Linkage Studies in Sheep, 9.
Wattles in Sheep, 9.
Wettstein, F. von, Morphologie und Physiologie des Formwechsels der Moose auf genetischer Grundlage II (Rev.), 80.

What Governs Population Growth (Rev.), Joseph J. Spengler, 321.
White House Conference and Heredity, E. P. Lyon, 92.
White House Conference, The Twentieth Pledge, 353.
Wilson, J. F., and D. W. Gregory, Sextuplet Lambs, 229.
Wing Mutation in a Borborid Fly, C. L. Turner, 35.
Winters, L. M., and E. E. Brockelbank, A Study of the Methods of Breeding the Best Shorthorns, 245.
Woollessness in Sheep, 91.

X

X-ray, Genetics, Aftereffect, 221.
X-rays, Changes Induced in Cotton by, 253.
X-ray, Reverse Genovariations Induced by, 67.

Y

Yak-Zebu Hybrids, 297.

Z

Zawadowsky, M. M., Zebu-Yak Hybrids, 297.
Zeller, John, et al, An Inbreeding Experiment with Poland China Swine, 393.

A Glossary Of Genetic Terms

GENETICS has developed so rapidly that many terms in common use in genetic literature are not yet incorporated in the dictionaries. Many people who are interested in heredity are bothered by such words, for which no definition can conveniently be found. For this reason, it is proposed to publish in each Journal a glossary of terms used in that issue which would not be readily understood and which are not to be found except in new unabridged dictionaries. It is realized that these definitions will probably not meet with universal approval, and comments and suggestions will be welcomed. It is believed that one function of such a glossary will be to standardize genetic terms, and to retard to some extent the "hybridization" of these words that in some instances is taking place.

ALLELOMORPH—Mendelian characters are inherited in alternative pairs, or in alternative series. These alternative genes are called allelomorphs. Examples: Albinism (recessive), Normal pigmentation (dominant); Horns (recessive), Hornlessness (dominant).

BLENDING INHERITANCE—Inheritance in which dominance and monohybrid segregation is lacking. Genetic and biometrical methods have shown this to be due, in many cases at least, to multiple factors independently inherited.

CHROMOSOMES—Tiny dark-staining bodies visible in the nucleus of the cell at the time of cell-division. The number of chromosomes in any species is usually constant. The chromosomes are made up of genes linearly arranged, which control the development of Mendelian characters.

DIPLOID—Having the normal paired chromosome arrangement found in somatic tissue, due to doubling of the primary chromosome complex at fertilization. See *Somatic*.

DOMINANT—A character possessed by one of the parents of a hybrid, which appears in the hybrid to the exclusion of the contrasted character from the other parent (the recessive). Thus in a cross of green- and yellow-seeded peas the first generation has yellow seeds. Yellow is dominant and green is recessive, being transmitted but not appearing in the presence of the factor for yellow.

FACTOR—Same as *Gene*.

F_1—(Pronounced eff-one). The first filial generation. The offspring of a given mating.

F_2—The second filial generation. Produced by intercrossing or self-fertilizing the F_1. The inbred grandchildren of a given mating.

GAMETE—A reproductive cell of either sex; sperm or ovum in animals, pollen grain or ovule in plants.

GENE—(1) The unit of inheritance, which is transmitted in the germ cells, and which by interaction with the genic and cytoplasmic complex controls the development of a character. The genes are arranged linearly in the chromosomes. (2) "The physical basis of heredity"—or more figuratively, the atom of the genetic molecule.

HETEROZYGOUS—Containing both genes of an allelomorphic pair, or two genes of an allelomorphic series. Heterozygous individuals generally resemble the individuals homozygous for the dominant character, but they transmit the recessive to half their offspring.

HOMOZYGOUS—(1) An organism formed by like germ cells; (2) An organism is said to be homozygous for a given character when all the germ cells transmit identical genes for this character. This is the most frequently used meaning of the term.

LINKAGE—Association of genes in inheritance, due to the fact that they are in the same chromosome.

MONOHYBRID—A hybrid whose parents differ in a single character. Monohybrid progenies are characterized by segregation for this character and its allelomorph in a 3:1 ratio.

MULTIPLE FACTORS—In the expression of some characters more than two genes are necessary. Such cumulative or cooperative genes are called multiple factors. See also *blending inheritance*.

MUTATION—A sudden variation in an inherited character.

PROBABLE ERROR—A value that any given error will be as likely to fall under as to exceed. A measure of the reliability of a statistical quantity (Mean, etc.).

PURE LINE—A strain of organisms that is genetically pure, due to continued inbreeding or self fertilization, or through other means.

RECESSIVE—See *Dominant*.

SEGREGATION—Separation of unlike genes at the time of fertilization.

SOMATIC—Resembling body tissues in having a paired set of chromosomes, one set from the female parent and one from the male, as contrasted with germ cells having a single set of chromosomes.

ZYGOTE—An organism produced by the union of two germ cells.